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THE NRL MICROWAVE SPACE RESEARCH FACILITY: OPERATING PROCEDURES OF THE COMPUTER CONTROL SYSTEM FOR THE 60-FT X-BAND ANTENNA

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13. ABSTRACT

In its primary mode of operation the 60-ft X-band antenna at NRL's Microwave Space Research Facility is positioned by means of a digital control system, the Navy Antenna Computer Tracking and Command (NACTAC) system. Both hardware design and software programming of the NACTAC system are operator oriented with respect to the manner in which requirements are defined and control is exercised.

Operating procedures for the NACTAC system can be separated into operator data entry to the NACTAC program via the typewriter at the computer console and operator actuation of switches at the main antenna control console. Source data may be entered by the operator at any time prior to its use and can include information on sites, frequencies, refraction, satellites, the sun, the moon, planets, and stars. Following the entry of source data, the operator then directs the system via the switches at the main control console. The operator can designate a fixed antenna position in coordinates of azimuth-elevation or right ascension-declination. Alternatively, he may select program tracking of some satellite or celestial object. Time offsets and angular offsets can be entered by the operator through thumbwheel switches on the control console for situations which require operator correction of the programmed tracking path. With the exception of certain cases, the operator may choose elliptical or spiral scan acquisition sequences centered around a program tracking point or designated fixed positions. Scan velocities and other parameters are controlled through thumbwheel switches on the control console. When a signal from either of two receivers is available during an operator-selected scan, a momentary acquisition will cause control to be transferred to a series of

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Computer						
Software						
Pushbutton control						
Antenna control						
Digital control						
Real time						
Satellites						
Scan						
Acquisition						
Control console						
Program tracking						
Time shared						
Executive level						
Operator oriented						
Typewriter response						
Data source						

computer-controlled procedures leading to acquisition and automatic tracking. A variety of displays continuously available to the operator at the control console further enhances his ability to maintain effective control.

System operating procedures are described in detail. They include computer startup, loading of the NACTAC system program, computer-operator dialogues for entering NACTAC source data, operator-designated selections available from the main control console, NACTAC diagnostics, data card formats, and computer shutdown procedures.

CONTENTS

ABSTRACT

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Operating procedures for the NACTAC system can be separated into operator data entry to the NACTAC program via the typewriter at the computer console and operator actuation of switches at the main antenna control console. Source data may be entered by the operator at any time prior to its use and can include information on sites, frequencies, refraction, satellites, the sun, the moon, planets, and stars. Following the entry of source data, the operator then directs the system via the switches at the main control console. The operator can designate a fixed antenna position in coordinates of azimuth-elevation or right ascension-declination. Alternatively, he may select program tracking of some satellite or celestial object. Time offsets and angular offsets can be entered by the operator through thumbwheel switches on the control console for situations which require operator correction of the programmed tracking path. With the exception of certain cases, the operator may choose elliptical or spiral scan acquisition sequences centered around a program tracking point or designated fixed positions. Scan velocities and other parameters are controlled through thumbwheel switches on the control console. When a signal from either of two receivers is available during an operator-selected scan, a momentary acquisition will cause control to be transferred to a series of computer-controlled procedures leading to acquisition and automatic tracking. A variety of displays continuously available to the operator at the control console further enhances his ability to maintain effective control.

System operating procedures are described in detail. They include computer startup, loading of the NACTAC system program, computer-operator dialogues for entering NACTAC source data, operator-designated selections available from the main control console, NACTAC diagnostics, data card formats, and computer shutdown procedures.

PROBLEM STATUS

AUTHORIZATION

THE NRL MICROWAVE SPACE RESEARCH FACILITY

Operating Procedures of the Computer Control System
for the 60-ft X-Band Antenna

INTRODUCTION

To extend the Navy's program in satellite communications, a fully steerable 60-foot X-band antenna system having a Cassegrainian configuration (Fig. 1) is now in operation at NRL's Microwave Space Research Facility located at Waldorf, Maryland (Fig. 2). Various aspects of the Waldorf antenna system have been discussed at length in other reports on the Microwave Space Research Facility (1,2).

The NRL designed and developed Navy Antenna Computer Tracking and Command (NACTAC) system is the real-time digital control system for the Waldorf 60-foot X-band antenna. The NACTAC system consists of both hardware and software elements for digital control of the antenna and for acquisition of data for processing and display (Fig. 3). This report, however, is concerned only with the operating procedures for computer control of the antenna system. As the communications link between the operator and the antenna, the software programs allow the operator to (a) enter program source data such
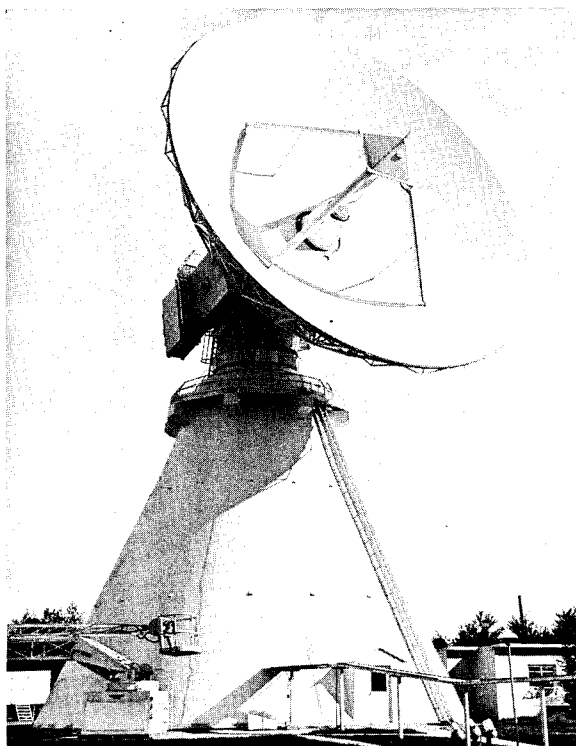

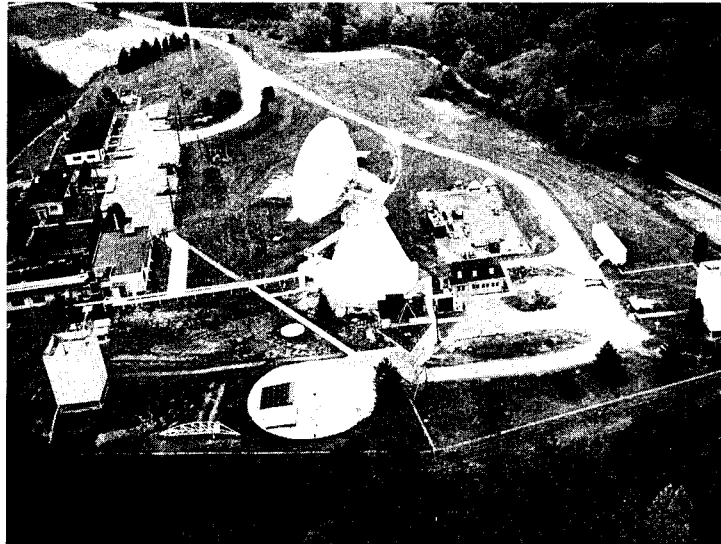Fig. 1 – The Waldorf 60-ft X-band antenna

1

Fig. 2 – Aerial view of the NRL Microwave
Space Research Facility

as that listed here; (b) designate a fixed antenna position; (c) select program tracking of a satellite of celestial object; (d) generate spiral or elliptical scans centered on fixed or program tracking points; (e) execute any one of a series of acquisition sequences, which, on acquisition, transfer control of the antenna to the automatic tracking mode; (f) enter program offsets in azimuth, elevation, and time; and (g) display the time, the antenna position, the position error, or the velocity and data on the local and on one remote site for an operator-defined source. NACTAC source data may be entered by the operator at any time prior to its use and can include information on sites, frequencies, refraction, satellites, the sun, the moon, planets, and stars. The operator may designate a fixed antenna position in coordinates of azimuth and elevation or right ascension and declination. Alternatively, he may select program tracking of some satellite or celestial object. To do this, the operator need only designate the source for which the data are desired, and the program will compute the object position in real time from such data as orbital elements and Naval Observatory data. When the antenna is in the digital mode, it will track the operator-designated program source or any other compatible remote source the operator selects.

Time offsets in azimuth and elevation can be entered by the operator through thumbwheel switches on the control console for situations which require operator correction of the programmed tracking path. In every case, real-time displays of the antenna position and the time are provided for the operator. If he so chooses, the operator may also have the difference between the antenna position and the programmed position displayed or, with the source object and frequency defined, the source range, range rate, doppler shift, and free-space attenuation. In the digital mode, the operator may select one of several scan acquisition sequences centered around the programmed tracking position. With the exception of certain cases, the operator may choose either spiral or elliptical scans whose parameters and scan velocities are designated through thumbwheel switches on the control console. When a signal from either of two receivers is available during an operator selected scan, a momentary acquisition will cause control to be transferred to a series of computer-controlled procedures leading to acquisition and automatic tracking.

MAIN CONTROL CONSOLE

TEST CONTROLLER CONSOLE

INTERFACE CONSOLE

ANTENNA ENCODERS

ANTENNA SERVO

MISCELLANEOUS CONTROLS AND INTERRUPTS

CLOCKS   INTERFACE RACKS

INTERRUPTS

SYSTEM TIMING

REAL-TIME EXECUTIVE CONTROL

ANTENNA CONTROL LEVEL

RE-ENTRANT LIBRARY FOR MULTI LEVEL REAL TIME USE

ANTENNA PROCESSING LEVEL

GENERAL LIBRARY AND STANDARD I/O DEVICES

4 MAGNETIC TAPE UNITS

I   LINE PRINTER

I   CARD READER

I   TYPEWRITER

I PAPER TAPE READER

I PAPER TAPE PUNCH

GENERAL PROGRAM EXECUTION AREA

GENERAL EXECUTIVE CONTROL

SPECIAL INTRINSIC OPERATIONS AND ROUTINES (MONITOR TYPE)

STANDARD I/O DRIVERS

MONITOR LEVEL

4   SATELLITES

2   CELESTIAL OBJECTS

3   SITES

3 FREQUENCIES

SOFTWARE ORGANIZATION

DATA PROCESSING LEVEL

MULTIPLEXER AND A/D CONVERTER

INTERFACE RACKS

D/A CONVERTERS

SIGNALS FROM RECEIVERS, MONITORING POINTS, ETC.
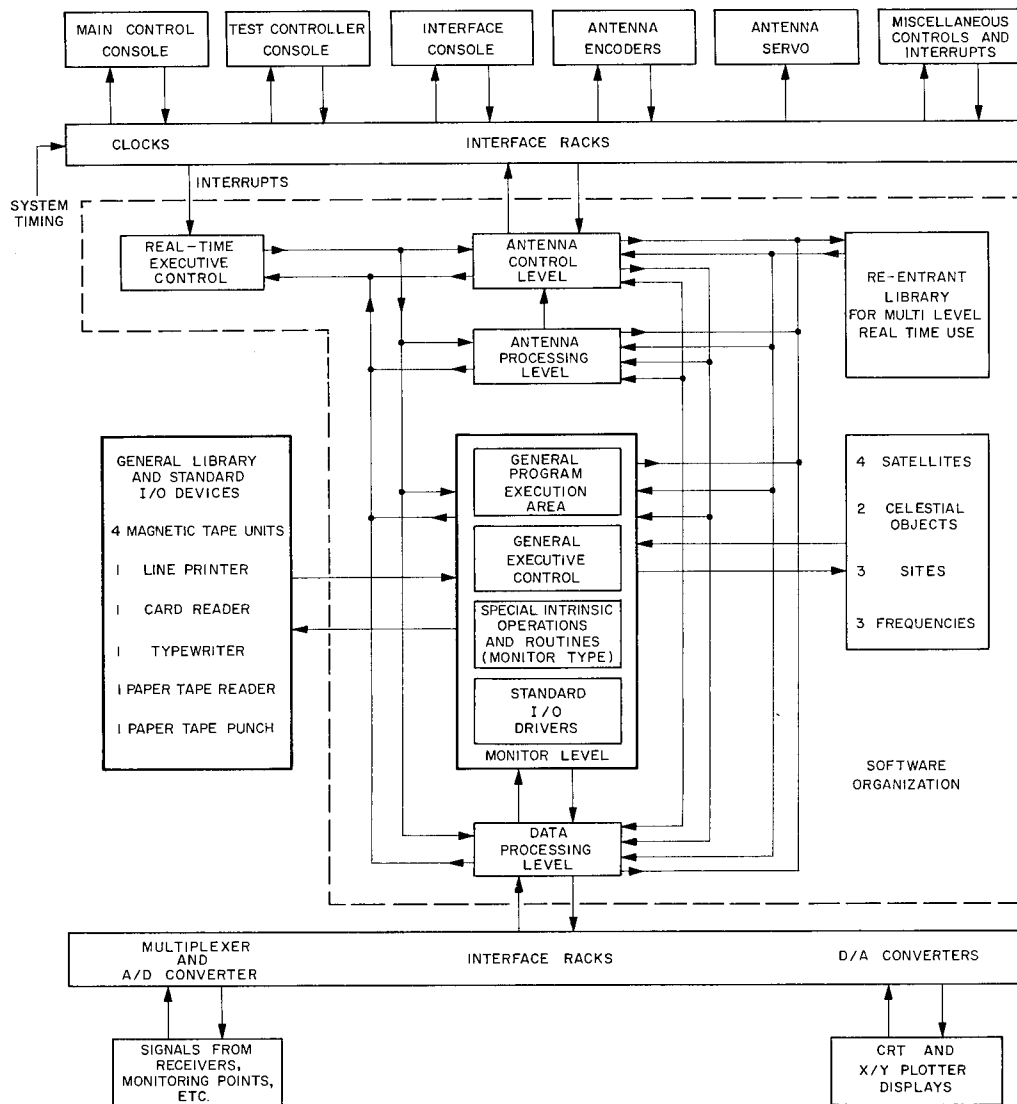
CRT AND X/Y PLOTTER DISPLAYS

Fig. 3 - NACTAC system block diagram

   The hardware portion of the NACTAC system includes a CDC 924A general purpose computer having a 16,384 word memory, four magnetic tape units, a card reader, a typewriter, a line printer, and other standard computer input/output (I/O) devices (Fig. 4). Control of the antenna is shared between four consoles: the computer console (Fig. 5), the interface console (Fig. 6), the test control console (Fig. 7), and the main control console (Fig. 8). Inputs to the system include the standard computer I/O hardware, thumbwheel switches, pushbutton switches, and special antenna interfaces. The lighted pushbutton switches do not provide direct control over any interface circuits with the exception of those controlling the real-time clock. The actuation of these switches is sensed by the software program to which the computer responds with software control of the associated light. System outputs associated with antenna control include the standard computer I/O hardware, digital in-line displays, and interfaces with the antenna servo system.
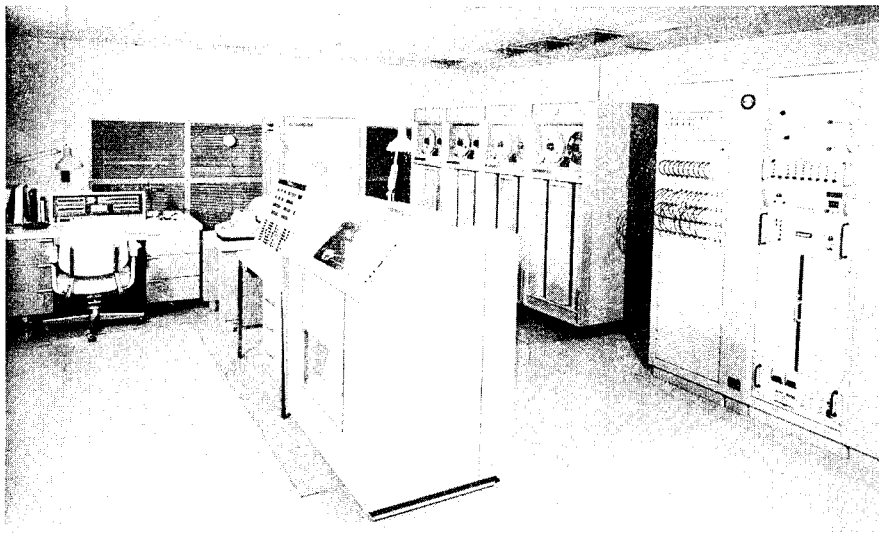

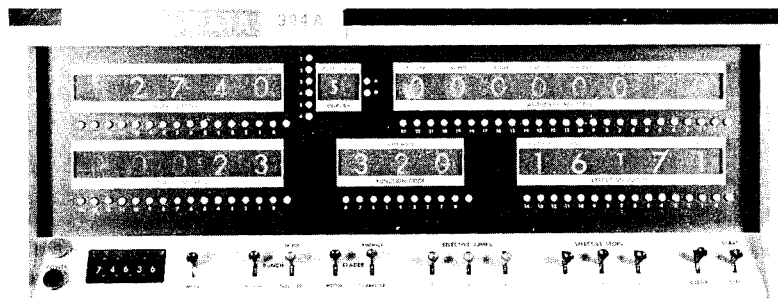Fig. 4 – Portions of the CDC 924A computer

Fig. 5 – Computer console
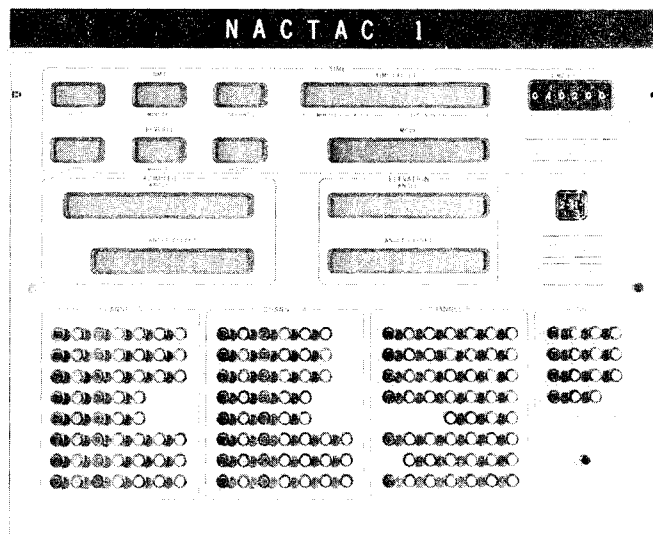
Fig. 6 – Interface console
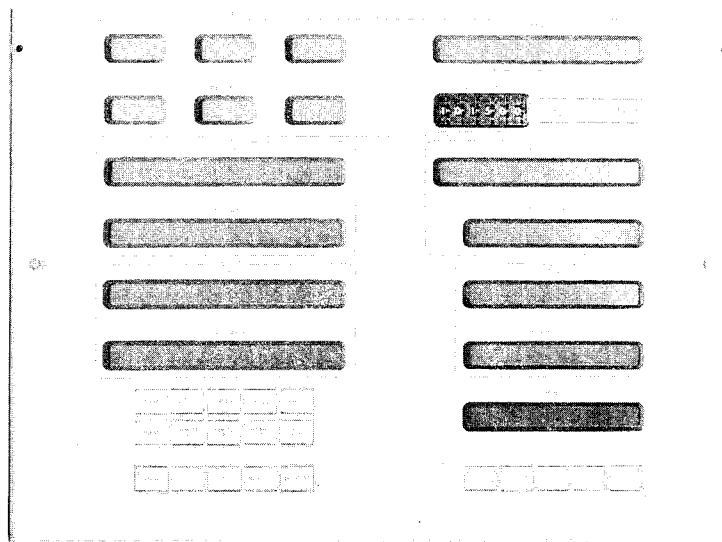
Fig. 7 – Test controller console
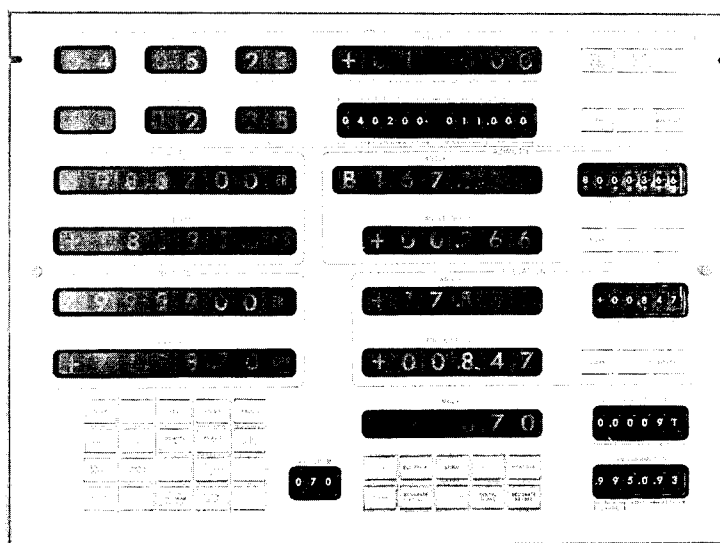
Fig. 8 – Main control console

The development and NACTAC system operating procedures were completed after installation of the computer. As sections of the operating procedures were completed, they were stored on magnetic tape. New sections, modifications, and corrections could then be easily made by additions or deletions to the stored information. A new manual can be made available to the operator in a matter of several minutes. The following sections of this report are an actual line printer listing of the NACTAC system operating procedures made at the Waldorf site from magnetic tape.

SYSTEM ORGANIZATION

THE NAVY ANTENNA COMPUTER TRACKING AND COMMAND SYSTEM (NACTAC) CONSISTS
BOTH OF HARDWARE AND SOFTWARE ELEMENTS. THE HARDWARE PORTION OF THE
SYSTEM CONSISTS OF THE FOLLOWING:

      (1) CDC 924A COMPUTER
      (2) FOUR MAGNETIC TAPE UNITS
      (3) LINE PRINTER
      (4) CARD READER
      (5) TYPEWRITER
      (6) PAPER TAPE READER
      (7) PAPER TAPE PUNCH
      (8) OTHER STANDARD COMPUTER I/O DEVICES
      (9) MAIN CONTROL CONSOLE
      (10) TEST CONTROLLER CONSOLE
      (11) INTERFACE SYSTEM INCLUDING THE INTERFACE CONSOLE, MULTIPLEXER,
           A/D CONVERTER, D/A CONVERTERS, AND SYSTEM CLOCKS
      (12) ANTENNA SERVO
      (13) ANTENNA ENCODERS
      (14) RECEIVING AND TRANSMITTING EQUIPMENT
      (15) X/Y PLOTTER AND CRT DISPLAYS
      (16) MISCELLANEOUS CONTROLS AND INTERRUPTS

THE SOFTWARE PORTION OF THE NACTAC SYSTEM IS CALLED NACSYS. NACSYS HAS
THE CAPABILITY OF OPERATING IN EITHER A REAL TIME OR NON-REAL TIME MODE.
IN THE NON-REAL TIME MODE, NACSYS CONSISTS OF A BASIC MONITOR SYSTEM,
GENERAL EXECUTIVE ROUTINES FOR CALLING AND EXECUTING BOTH INTRINSIC AND
EXPLICIT ROUTINES, AND THE INPUT/OUTPUT (I/O) DRIVERS. INTRINSIC
ROUTINES ARE ENTIRELY SELF-CONTAINED AND PERFORM SUCH FUNCTIONS AS THE
CONTROL, READING, WRITING, AND LISTING OF TAPES. EXPLICIT ROUTINES ARE
CALLED FROM A GENERAL LIBRARY MASTER TAPE FOR EXECUTION, AFTER WHICH
CONTROL IS RETURNED TO THE MONITOR PORTION OF NACSYS. THEREFORE, WHEN IN
NON-REAL TIME MODE, THIS SYSTEM CAN BE COMPARED TO A BATCH PROCESSING
SYSTEM HAVING TYPEWRITER CONTROL.

IN THE REAL TIME MODE, NACSYS IS A MULTI-LEVEL, MULTI-PROGRAMMED,
TIME-SHARED SYSTEM CONSISTING OF FOUR PRIMARY LEVELS WITH FIXED
PRIORITIES UNDER THE CONTROL OF A SPECIAL REAL TIME EXECUTIVE. IN
ADDITION TO THESE FOUR PRIMARY LEVELS, THERE ARE ALSO A NUMBER OF SUB-
LEVELS WHICH HAVE NO ASSIGNED PRIORITIES BUT WHICH OPERATE ON A FIRST
COME FIRST SERVED BASIS. IN THE ORDER OF DECREASING PRIORITY, THE
PRIMARY LEVELS ARE ANTENNA CONTROL, ANTENNA PROCESSING, MONITOR, AND
DATA PROCESSING. THE BASIC NON-REAL TIME PORTION OF THE SYSTEM
OPERATES ON THE MONITOR LEVEL IN REAL TIME RETAINING ALL OF THE SYSTEM
CAPABILITIES WITH THE EXCEPTION OF CERTAIN ROUTINES ON THE MASTER TAPE
WHICH ARE ONLY ALLOWED IN NON-REAL TIME OPERATION. THE MONITOR LEVEL
CONTAINS THE GENERAL PROGRAM EXECUTION AREAS FOR NACSYS IN ADDITION TO
THE GENERAL EXECUTIVE CONTROL, SPECIAL INTRINSIC MONITOR LEVEL
OPERATIONS, AND THE STANDARD I/O DRIVERS FOR NACSYS. ONLY THE MONITOR
LEVEL HAS ACCESS TO THE GENERAL LIBRARY TAPES ON THE MASTER TAPE AND THE
STANDARD I/O DEVICES, WHICH INCLUDE THE MAGNETIC TAPE UNITS, THE LINE
PRINTER, THE CARD READER, THE TYPEWRITER, THE PAPER TAPE READER, AND
THE PAPER TAPE PUNCH.

THE FOUR PRIMARY LEVELS ARE ADMINISTERED BY A REAL TIME EXECUTIVE WHICH,
UPON AN EXTERNAL OR INTERNAL INTERRUPT NOT AFFECTING A NON-PRIORITY
CONTROLLED SUB-LEVEL, EXAMINES THE CURRENT STATUS OF EACH OF THE PRIMARY
LEVELS AND DESIGNATES WHICH LEVEL IS TO BE USED BASED UPON ITS PRIORITY
AND STATUS. BEFORE OPERATING ON THIS LEVEL, HOWEVER, THE PREVIOUS LEVEL
INFORMATION SUCH AS REGISTERS, FAULTS, AND BRANCHING LOCATIONS IS SAVED
AND THE NEWLY DESIGNATED LEVEL INFORMATION IS RESTORED. THE REAL TIME
EXECUTIVE THEN TRANSFERS CONTROL TO THIS LEVEL.

IN THE REAL TIME MODE, A COMPREHENSIVE FULLY REENTRANT LIBRARY IS
AVAILABLE FOR USE BY ANY OF THE FOUR PRIMARY LEVELS. DATA ON UP TO FOUR
SATELLITES, TWO CELESTIAL OBJECTS, THREE SITES, AND THREE FREQUENCIES IS
ALSO AVAILABLE TO ANY OF THE FOUR PRIMARY LEVELS. THIS DATA IS ENTERED
AND PROCESSED BY ROUTINES DESIGNATED BY THE MONITOR LEVEL.

CONTROL LOCATIONS

SEVERAL CONTROL LOCATIONS ARE INVOLVED WITH OPERATION OF THE
DIGITAL CONTROL SYSTEM AT WALDORF. THESE MAY BE BROKEN DOWN INTO
THE FOLLOWING CATEGORIES: THE COMPUTER CONSOLE, TYPEWRITER, INTERFACE
CONSOLE, TEST CONTROL CONSOLE, AND THE MAIN ANTENNA CONTROL CONSOLE.
THE COMPUTER CONSOLE, TYPEWRITER, AND INTERFACE CONSOLE ARE LOCATED
TOGETHER AND ARE INTENDED TO BE OPERATED BY ONE PERSON. HEREAFTER,
THE CONTROL LOCATIONS SHALL BE REFERRED TO AS STATIONS. STATION 1
WILL BE THE COMPUTER CONSOLE. STATION 2 WILL BE THE TYPEWRITER.
STATION 3 WILL BE THE INTERFACE CONSOLE. STATION 4 WILL BE THE
TEST CONTROL CONSOLE. AND, STATION 5 WILL BE THE MAIN ANTENNA CONTROL
CONSOLE.

STATION 1, THE COMPUTER CONSOLE, CONTAINS THE NECESSARY SWITCHES AND
DISPLAYS FOR THE OPERATION OF THE COMPUTER. IN ADDITION, IT CONTAINS
THE PAPER TAPE READER WHEREBY A BOOTSTRAP PROGRAM IS LOADED INTO THE
COMPUTER IN ORDER TO BRING IN THE SOFTWARE OPERATING SYSTEM FROM THE
MASTER MAGNETIC TAPE UNIT.

STATION 2, THE TYPEWRITER, IS THE POINT AT WHICH ALL SUPPLEMENTARY DATA
REQUESTED FROM THE OPERATOR IS ENTERED INTO THE SYSTEM. FOR THIS REASON
THE NAVY ANTENNA COMPUTER TRACKING AND COMMAND SYSTEM (NACTAC) IS
TYPEWRITER ORIENTED. THE OTHER SOURCES OF DATA INPUT (NOT UNDER DIRECT
HARDWARE CONTROL) INCLUDE THE CARD READER, THE PAPER TAPE READER, AND THE
MAGNETIC TAPE UNITS. THESE LAST THREE ARE NOT CONSIDERED AS STATIONS,
HOWEVER, SINCE THEY ARE NOT POINTS OF CONTROL.

STATIONS 3, 4, AND 5 PANELS ARE COMPRISED OF LIGHTED PUSHBUTTON SWITCHES,
THUMBWHEEL SWITCHES, IN-LINE DISPLAYS, AND, IN THE CASE OF STATION 3
ONLY, INDICATOR LAMPS FOR INTERFACE MONITORING. UNIQUE TO STATION 3 ALSO
IS THE NACTAC 1 DISPLAY WHICH PROVIDES THE REAL TIME CLOCK SUBCOUNT
DISPLAY (THE FOUR BINARY BITS PRIOR TO THE SECONDS COUNT).

THE LIGHTED PUSHBUTTON SWITCHES (WITH THE EXCEPTION OF THE REAL TIME
CLOCK CONTROL GROUP ON THE STATION 3 AND 5 PANELS AND THE VARIABLE CLOCK
CONTROL GROUP ON THE STATION 3 PANEL) DO NOT PROVIDE DIRECT CONTROL OVER
ANY INTERFACE HARDWARE. THE ACTUATION OF THESE SWITCHES IS SENSED BY THE
SOFTWARE PROGRAM TO WHICH THE COMPUTER RESPONDS WITH SOFTWARE CONTROL OF
THE ASSOCIATED LIGHT. IN THE EXCEPTED CASE OF REAL TIME CLOCK CONTROL,
THE PUSHBUTTONS EXERCISE DIRECT CONTROL OVER THE HARDWARE GMT REAL
TIME CLOCK. THE SOFTWARE PROGRAM HAS ACCESS ONLY TO THE CLOCK
OUTPUT OF GMT HOURS, MINUTES, SECONDS, AND SUBCOUNT. IT DOES NOT HAVE
ANY CONTROL OVER THE FUNCTIONS PERFORMED BY THE REAL TIME CLOCK SWITCHES,
ALTHOUGH OTHER CONTROLLING PULSES ARE PRODUCED BY THE HARDWARE GMT CLOCK
FOR CONTROL OF THE SAMPLE AND SUBSAMPLE TIMES.

IN THE CASE OF THE VARIABLE CLOCK, THE SAME FUNCTIONS WHICH ARE PERFORMED
BY ACTUATING THE PUSHBUTTON SWITCHES AT STATION 3 ARE ALSO CAPABLE OF
BEING PUT UNDER SOFTWARE CONTROL. IN THE LATTER CASE, THE APPROPRIATE
PUSHBUTTON SWITCH AT STATION 3 WILL BE LIGHTED WHEN THE SOFTWARE PROGRAM
HAS INITIATED SUCH CONTROL.

THE 'INDICATOR LIGHTS AT STATION 3 FOR CHANNELS 3, 4, 5, AND 6 PERFORM
FUNCTIONS OF INTERFACE MONITORING. THEY ARE USEFUL PRIMARILY IN THE
PREPARATION AND DEBUGGING OF PROGRAMS; WHILE, AT THE SAME TIME, THEY
PROVIDE A MEANS OF LOCATING SYSTEM MALFUNCTIONS.

THE THUMBWHEEL SWITCHES (WITH THE EXCEPTION OF THE GMT REAL TIME CLOCK
AT STATIONS 3 AND 5 AND THE VARIABLE TIME THUMBWHEEL SWITCHES AT STATION
3) PROVIDE THE MEANS OF ENTERING CORRESPONDING DATA TO THE SOFTWARE
PROGRAM. THE REAL AND VARIABLE TIME SWITCHES GO DIRECTLY TO HARDWARE;
BUT, IN THE CASE OF THE GMT CLOCK, NO OVERLAPPING FUNCTIONS ARE AVAILABLE
THROUGH SOFTWARE PROGRAM CONTROL. FOR THE VARIABLE CLOCK, HOWEVER,
SOFTWARE PROGRAM CONTROL DOES EXIST TO PERFORM IDENTICAL FUNCTIONS. THE
SWITCH SETTINGS AT STATION 3 ARE DISPLAYED ON CHANNEL 5, THE DISPLAY
BEING CONTROLLED EITHER AT STATION 3 OR BY THE SOFTWARE PROGRAM.

ALL OF THE IN-LINE DISPLAYS (WITH THE EXCEPTION OF THE GMT REAL TIME
CLOCK) ARE UNDER SOFTWARE PROGRAM CONTROL. THE GMT CLOCK IS DIRECTLY A
PART OF THE HARDWARE CLOCK.

START-UP PROCEDURE

A. TURN ON THE COMPUTER POWER WITH THE BLUE SWITCH LOCATED ON THE
COMPUTER CONSOLE. MASTER CLEAR THE COMPUTER BY FIRST PUSHING THE
MASTER CLEAR LEVER UP AND THEN DOWN.

B. TURN ON THE INTERFACE EQUIPMENT AS FOLLOWS:

    (1) THE WITH COMPUTER/BYPASS SWITCH ON THE WALL BESIDE THE CIRCUIT
        BREAKERS WILL UNCONDITIONALLY TURN ON THE INTERFACE EQUIPMENT
        WHEN IT IS IN THE BYPASS POSITION.

    (2) THE INTERFACE EQUIPMENT WILL BE TURNED ON WITH THE COMPUTER
        WHEN THE WITH COMPUTER/BYPASS SWITCH IS IN THE WITH COMPUTER
        POSITION.

C. TURN ON THE LINE PRINTER MAINTAINING THE FOLLOWING SEQUENCE:

    (1) TURN ON THE PRINTER LOGIC.
    (2) TURN ON THE PRINTER (MOTOR).
    (3) MASTER CLEAR THE PRINTER.
    (4) TURN ON THE ZERO DISABLE.
    (5) TO ADVANCE THE PAPER ONE PAGE, THE FORMAT HOME PUSHBUTTON MAY
        OPTIONALLY BE USED.

D. TURN ON THE CARD READER AS FOLLOWS:

    (1) PLACE THE ON LINE-OFF LINE SWITCH IN THE ON LINE POSITION.
    (2) TURN ON THE ROW CHECK, ZERO DISABLE.
    (3) TURN ON THE MOTOR POWER.
    (4) THE STOP PUSHBUTTON IS OPTIONALLY ON OR OFF; HOWEVER, IN THE ON
        POSITION, THE CARD READER CANNOT BE ACTIVATED BY THE SOFTWARE
        PROGRAM.

E. TURN ON THE MAGNETIC TAPE UNITS AS FOLLOWS:

    (1) TO APPLY POWER TO THE MAGNETIC TAPE UNITS OPEN THE DOORS AT THE
        REAR OF THE TRANSPORT CABINET AND PUSH ALL SWITCHES ON THE POWER
        SUPPLY TO THE ON POSITION. THE INDICATOR LAMP UNDER THE MAIN
        POWER SWITCH SHOULD LIGHT.
    (2) PRESS THE SWITCH LOCATED AT THE UPPER LEFT CORNER OF THE LOGIC
        CHASSIS IN THE REAR OR THE SWITCH BEHIND THE TAPE UNIT NUMBER
        PANEL IN THE FRONT. THE POWER TO THE TAPE UNIT SHOULD
        NOW BE ON.
    (3) SLIDE THE GLASS FRONT DOOR DOWN TO ITS LOWEST POSITION.
    (4) TURN THE FLUTED PLASTIC KNOB ON THE LEFT REEL HUB COUNTER-
        CLOCKWISE TWO OR THREE TURNS. SLIDE AN EMPTY TAPE REEL ONTO THE
        HUB AND TIGHTEN THE KNOB CLOCKWISE WHILE PRESSING THE REEL
        FIRMLY ONTO THE HUB.

(5) TURN THE KNOB ON THE RIGHT REEL HUB COUNTER-CLOCKWISE. SLIDE
    THE TAPE MARKED NACSYS MASTER ONTO THE HUB SO THAT THE TAPE
    UNWINDS FROM THE REEL ON THE RIGHTHAND SIDE. TIGHTEN THE KNOB
    CLOCKWISE WHILE PRESSING THE REEL FIRMLY ONTO THE HUB.
(6) PUSH THE LOAD ARMS LOCATED OUTSIDE AND BELOW THE TAPE REELS TO
    THE UP POSITION.
(7) THREAD TAPE FROM THE SUPPLY REEL AROUND THE SUPPLY LOAD ARM,
    UNDER THE TAKE-UP LOAD ARM, AND ONTO THE TOP OF THE TAKE-UP
    REEL.
(8) PRESS THE TAPE ONTO THE TAKE-UP REEL THROUGH ONE OF THE OPENINGS
    IN THE SIDE OF THE REEL, AND TURN THE REEL THREE TURNS TO HOLD
    THE TAPE ON THE REEL.
(9) SLIDE THE TAPE UNDER THE TAPE HEAD ASSEMBLY.
(10) PUSH BOTH LOAD ARMS DOWN.
(11) RAISE THE FRONT DOOR.
(12) PRESS THE CLEAR SWITCH.
(13) PRESS THE HIGH DENSITY SWITCH.
(14) PRESS THE LOAD SWITCH ON THE OPERATORS PANEL. TAPE SHOULD NOW
    BE DRAWN INTO THE LOOP BOXES, AND THEN ADVANCED UNTIL THE LOAD
    POINT MARKER IS DETECTED. MOTION WILL STOP. THE LOAD POINT
    INDICATOR ON THE OPERATORS PANEL WILL LIGHT AND REMAIN LIGHTED
    UNTIL THE TAPE IS MOVED AWAY FROM THE LOAD POINT BY THE
    PROGRAM.
(15) PRESS THE READY SWITCH.
(16) SET THE NACSYS TAPE UNIT NUMBER TO 1, AND MAKE SURE THAT NO TWO
    TAPE UNITS HAVE THE SAME UNIT NUMBER EXCEPT FOR STANDBY.
(17) REPEAT STEPS (1) THROUGH (15) FOR THE TAPE MARKED CELESTIAL
    FILES. DESIGNATE THIS UNIT NUMBER 2 MAKING SURE THAT NO TWO
    UNITS HAVE THE SAME UNIT NUMBER EXCEPT FOR STANDBY.

F. THE BREAKPOINT THUMBWHEEL SWITCH ON THE COMPUTER CONSOLE MUST BE SET
TO 77777.

G. ALL OF THE LEVER SWITCHES ON THE COMPUTER SHOULD BE IN THEIR NEUTRAL,
OR CENTER, POSITIONS; HOWEVER, THE PUNCH LEVER SWITCH MAY OPTIONALLY BE
IN THE TAPE SELECT POSITION.

NOTE: THE LEVER SWITCHES SHOULD NEVER BE SNAPPED SINCE THE CONTACT BOUNCE
      THUS INTRODUCED MAY GIVE RISE TO ERRORS. INSTEAD, THEY SHOULD BE
      MOVED FIRMLY AND DELIBERATELY FROM ONE POSITION TO ANOTHER.

H. MASTER CLEAR THE COMPUTER BY FIRST PUSHING THE MASTER CLEAR LEVER UP
AND THEN DOWN. THIS ORDER SHOULD BE MAINTAINED TO AVOID ANY POSSIBLE
DIFFICULTIES.

I. PLACE THE MODE LEVER SWITCH IN ITS DOWNWARD POSITION. THE BACKGROUND
LIGHTS ON THE FUNCTION CODE DISPLAY SHOULD BE BLUE.

J. PLACE THE NACSYS BOOTSTRAP PAPER TAPE IN THE PAPER TAPE READER BIN
SO THAT THE SPROCKET HOLES ARE CLOSEST TO THE INSIDE EDGE OF THE TAPE
READER AND CLAMP IT INTO POSITION. IF IT IS PROPERLY IN THE TAPE READER,
THE TAPE SHOULD MOVE FREELY.

K. THE READER MOTOR SHOULD BE TURNED ON BY PLACING THE READER MOTOR LEVER
IN THE UP POSITION; AND, ASSUMING THAT THE LEADER OF THE TAPE HAS BEEN
CORRECTLY PLACED IN THE TAPE READER, THE READER LEVER SWITCH SHOULD BE
PLACED IN THE ASSEMBLY POSITION. THE TAPE WILL ADVANCE UNTIL THE
READER ENCOUNTERS THE FIRST CHARACTER ON THE TAPE AND THEN STOP. TO
BEGIN READING THE TAPE, THE START-STEP LEVER SWITCH SHOULD BE MOVED TO
THE START POSITION. THE TAPE WILL THEN PROCEED TO BE READ INTO MEMORY
UNTIL THE LAST DATA FRAME ON THE TAPE IS ENCOUNTERED.

L. REMOVE THE TAPE FROM THE TAPE READER AND REWIND IT.

NOTE: THE TAPE LOADING PROCEDURE OUTLINED HERE MAY BE BYPASSED IF THE
       PROGRAM IS ALREADY IN MEMORY.

M. RETURN THE MODE LEVER SWITCH TO ITS CENTER POSITION AND MOVE THE CLEAR
SWITCH UP.

N. MOVE THE START-STEP LEVER TO THE START POSITION. ONCE THIS HAS BEEN
DONE THE TYPEWRITER WILL BE ACTIVATED AND A REQUEST FOR INPUT DATA WILL
BE MADE.

ASSUMING THAT THIS LAST STEP HAS BEEN REACHED, THE PROGRAM HAS BEEN
SUCCESSFULLY ENTERED INTO MEMORY AND ACTIVATED. EXCEPT FOR THE SETTING
OF THE GMT CLOCK, ALL OF THE REMAINING DATA REQUESTS WILL BE MADE BY THE
PROGRAM.

IF, FOR SOME REASON, THE OPERATOR SHOULD DESIRE TO REINITIATE THE INPUT
REQUEST PROCEDURES WITHOUT DESTROYING ANY DATA WHICH MAY ALREADY BE IN
MEMORY EXCEPT FOR THE DATA SOURCE DESIGNATED BY THE ROUTINE TRACK, HE
SHOULD START THE PROGRAM FROM PROGRAM ADDRESS 00001 INSTEAD OF THE
CUSTOMARY PROGRAM ADDRESS 00000. THE DATA SOURCE FOR PROGRAM TRACK MUST
BE REDESIGNATED. RESTARTING FROM PROGRAM ADDRESS 00000 WILL CLEAR ALL OF
THE RESERVED DATA BLOCKS.

INPUT REQUESTS

ONCE THE PROGRAM HAS BEEN SUCCESSFULLY ENTERED INTO MEMORY AND ACTIVATED,
THE TYPEWRITER WILL REPLY WITH THE REQUEST--NACSYS:. IF THE OPERATOR
DESIRES A LISTING OF THE DIRECTORY OF PROGRAMS, SUBPROGRAMS, AND ROUTINES
WHICH MAY BE USED BY NACSYS, HE SHOULD REPLY AS FOLLOWS:

       NACSYS: RWND.I
       NACSYS: LIST.I

IN EXECUTING THE FIRST REQUEST, TAPE UNIT I WILL REWIND UNTIL IT
COMES TO THE LOAD POINT WHERE IT WILL STOP. THE SECOND REQUEST WILL LIST
ON THE LINE PRINTER THE CONTENTS OF THE FIRST FILE ON TAPE UNIT I.
THE LISTING OF THE DIRECTORY MAY BE REMOVED FROM THE LINE PRINTER BY
ADVANCING THE PAPER WITH THE FORMAT HOME PUSHBUTTON.

THE NAMES ACCEPTABLE AS REPLYS TO THE REQUEST--NACSYS:--ARE FOUND IN THE
SECOND COLUMN OF THE DIRECTORY. THE LAST COLUMN IN THE DIRECTORY GIVES
A BRIEF STATEMENT ON THE FUNCTION OF THE PROGRAM, SUBPROGRAM, OR ROUTINE
CONCERNED, AND THE FOURTH COLUMN CONTAINS A TWO CHARACTER ALPHANUMERIC
CODE WITH THE FOLLOWING INTERPRETATIONS:

       0 INDICATES A NON-ACCESSABLE ROUTINE
       I INDICATES A NON-REAL TIME ROUTINE
       2 INDICATES A REAL TIME ROUTINE
       3 INDICATES A COMBINATION REAL TIME/NON-REAL TIME ROUTINE
       A INDICATES AN ABSOLUTELY ADDRESSED ROUTINE
       R INDICATES A RELOCATABLE ROUTINE

A SECOND DIRECTORY CONTAINING INPUT DATA FOR SOME, BUT NOT ALL, OF THE
PROGRAMS LISTED IN THE SYSTEM DIRECTORY IS AVAILABLE FROM THE TAPE MARKED
DATA FILES. TO OBTAIN A LISTING OF THIS DIRECTORY, THE OPERATOR SHOULD
REPLY AS FOLLOWS:

       NACSYS: RWND.2
       NACSYS: LIST.2

IN EXECUTING THE FIRST REQUEST, TAPE UNIT 2 WILL REWIND UNTIL IT COMES
TO THE LOAD POINT WHERE IT WILL STOP. THE SECOND REQUEST WILL LIST ON

THE LINE PRINTER THE CONTENTS OF THE FIRST FILE ON TAPE UNIT 2. THE
LISTING OF THE DIRECTORY MAY BE REMOVED FROM THE LINE PRINTER BY
ADVANCING THE PAPER WITH THE FORMAT HOME PUSHBUTTON. SINCE THE DATA FOR
THE PROGRAMS LISTED ON THE DATA FILES TAPE IS AVAILABLE, THE OPERATOR
MAY SELECT TAPE INPUT WHEN THE PROGRAM REQUEST--CARD OR TAPE:--IS MADE.

PROGRAM, SUBPROGRAM, OR ROUTINE NAMES USED WITH NACSYS CAN BE NO LONGER
THAN EIGHT LOWERCASE ALPHANUMERIC CHARACTERS. IF THE NAME HAS LESS THAN
EIGHT CHARACTERS, IT MUST BE TERMINATED WITH A PERIOD; OTHERWISE,
TRAILING SPACES MUST BE INSERTED IN ORDER TO COMPLETE THE NAME.
IN ADDITION, THE FIRST CHARACTER OF A NAME MUST BE ALPHABETIC (EXCEPT FOR
SPECIAL CASES). IF A CARRIAGE RETURN IS EXECUTED BEFORE THE COMPLETION
OF A NAME, CONTROL WILL BE RETURNED TO THE BEGINNING OF NACSYS.

ASSUMING THAT CONTROL HAS BEEN RETURNED TO THE BEGINNING OF THE NACSYS
PROGRAM, THE TYPEWRITER WILL RESPOND WITH NACSYS:. IF THE OPERATOR
SELECTS NACTAC, THE BASIC REAL TIME SYSTEM PROGRAM (LOADED IN NON-REAL
TIME), ONLY THE REAL TIME MODE ROUTINES WILL BE PERMITTED. IF, ON THE
OTHER HAND, NACTAC IS NOT SELECTED, ONLY THE NON-REAL TIME MODE ROUTINES
WILL BE PERMITTED. INTRINSIC ROUTINES ARE ALLOWED IN BOTH MODES. THE
REPLY TO AN INPUT REQUEST WILL FOLLOW A COLON OR AN EQUALS SIGN. SYMBOLS
SUCH AS SLASHES, PERIODS, AND (IN SPECIAL CASES) ALPHABETIC CHARACTERS
WILL BE TYPED BACK BY THE PROGRAM AS PART OF THE OPERATOR'S REPLY.

NON-REAL TIME PROGRAMS INCLUDE ROUTINES FOR ASSEMBLING PROGRAMS AND
FOR TESTING AND MAINTAINING THE COMPUTER AND ITS PERIPHERAL EQUIPMENT.
THE COMBINATION REAL TIME/NON-REAL TIME PROGRAMS LIST THE CONTENTS OF
CORE MEMORY ONTO THE LINE PRINTER. SINCE THESE TYPES OF PROGRAMS ARE
PRIMARILY MAINTAINENCE ORIENTED AND ARE NOT USED IN NORMAL OPERATIONS,
THEY WILL NOT BE CONSIDERED FURTHER.

REAL TIME ROUTINES

THE REAL TIME PROGRAMS ARE THOSE WHICH APPEAR ON THE DIRECTORY WITH
CODES 2A AND 2R.

LOADED IN NON-REAL TIME, NACTAC IS THE BASIC REAL TIME SYSTEM PROGRAM
WHICH PROVIDES THE CONTROL FOR ALL OF THE REAL TIME ROUTINES. ONCE
NACTAC HAS BEEN ACTIVATED, IT WILL REQUEST THE OPERATOR TO INPUT DATA.
THE TYPEWRITER REQUESTS ARE AS FOLLOWS:

NACSYS: NACTAC.

INPUT INITIAL INFORMATION

TYPE DATE (MON/DAY/YR):   --/--/--

    THE REPLY CONSISTS OF THE DATE IN THE FORMAT INDICATED; E.G.,
    12/01/67 FOR DECEMBER 1, 1967. TWO DIGITS MUST BE USED IN EACH
    POSITION OF THE FORMAT.

TYPE EQUATION OF EQUINOXES: -.XXX

    THE REPLY IS A NUMBER LISTED IN THE AMERICAN EPHEMERIS AND NAUTICAL
    ALMANAC UNDER UNIVERSAL AND SIDEREAL TIMES AS THE EQUATION OF
    EQUINOXES; E.G., -.518 FOR DECEMBER 1, 1967.

MAKE INPUT REQUESTS

AT THIS TIME, THE GMT CLOCK, IF NOT PREVIOUSLY SET, MUST NOW BE SET. THE
STARTING OF THE CLOCK IS ABSOLUTE; I. E., IT IS INDEPENDENT OF THE
DISPLAYS AND DOES NOT REQUIRE THAT THEY BE TURNED ON. THE PROCEDURE FOR
SETTING THE GMT REAL TIME CLOCK IS AS FOLLOWS:

(1) SET THE TIME PRESET THUMBWHEEL SWITCHES AT STATION 3 OR 5 TO THE
    DESIRED TIME.
(2) PRESS THE STOP-PRESET PUSHBUTTON AT STATION 3 OR 5.
(3) FOR AUTOMATIC STARTING, THE TIME PRESET SHOULD BE SET FOR THE
    NEXT GMT MINUTE POINT. PRESS THE AUTO-START AND SYNCH
    PUSHBUTTON. AT THE NEXT MINUTE POINT, THE CLOCK WILL START IN
    CORRECT SYNCHRONIZATION.
(4) FOR MANUAL STARTING, SET THE TIME PRESET AND PRESS THE MANUAL
    START BUTTON WHEN THE ACTUAL GMT TIME AND THE TIME PRESET
    COINCIDE.

WITH THE EXCEPTION OF FREQUENCY AND REFRACTION DATA, SUPPLEMENTARY DATA
IS INPUTED VIA CARD OR MAGNETIC TAPE. APPROPRIATE DIAGNOSTICS AND ERROR
MESSAGES WILL BE RETURNED IF THE SUPPLEMENTARY DATA IS NOT INPUTED
CORECTLY.

SUPPLEMENTARY DATA FOR THE FREQUENCY, REFRACTION, SITE, SATELLITE ORBITS,
AND CELESTIAL ORBITS (INCLUDING THE SUN, MOON, PLANETS, AND STARS) MAY BE
ENTERED NOW. IT MAY ALSO BE ENTERED AT ANY FUTURE TIME, WITH SOME
RESTRICTIONS. THE PROCEEDURE IS OUTLINED BELOW.

    NACSYS: XXXXX. OR XXXXXXXX

    THIS REQUEST IF FOLLOWED BY ONE OF SEVERAL REAL TIME ROUTINES. THE
    ROUTINE NAMES CAN BE NO LONGER THAN EIGHT LOWERCASE ALPHANUMERIC
    CHARACTERS. IF THE NAME HAS LESS THAN EIGHT CHARACTERS, IT MUST BE
    TERMINATED WITH A PERIOD; OTHERWISE, TRAILING SPACES MUST BE
    INSERTED IN ORDER TO COMPLETE THE NAME. IF A CARRIAGE RETURN IS
    EXECUTED BEFORE THE COMPLETION OF A NAME, CONTROL WILL BE RETURNED
    TO THE BEGINNING OF NACSYS. EXIT (NOT LISTED AS ONE OF THE
    ROUTINES) WILL RETURN CONTROL TO THE BEGINNING OF NACSYS FROM MOST
    INSERTED IN ORDER TO COMPLETE THE NAME. EXIT (NOT LISTED AS ONE OF
    THE ROUTINES) WILL RETURN CONTROL TO THE BEGINNING OF NACSYS FROM
    MOST OF THE DATA INPUT POINTS FOUND WITHIN THESE ROUTINES. IF A
    CARRIAGE RETURN IS EXECUTED BEFORE THE COMPLETION OF A NAME, CONTROL
    WILL BE RETURNED TO THE BEGINNING OF NACSYS AGAIN.

    IF A PAUSE ON THE CARD READER, TAPE UNITS, AND/OR LINE PRINTER IS
    DESIRED, ACTUATE JUMP KEY 1 ON THE COMPUTER CONSOLE. PROCESSING
    MAY BE RESUMED BY RETURNING JUMP KEY 1 TO ITS CENTER POSITION.
    IF A TERMINATION IN THE I/O FROM THE CARD READER, TAPE UNITS AND/OR
    LINE PRINTER AND A RETURN TO THE BEGINNING OF NACSYS IS DESIRED,
    DEPRESS JUMP KEY 2.

    A SINGLE PERIOD, SPACES FOLLOWED BY A PERIOD, OR EIGHT SPACES WILL
    CAUSE A JUMP TO THE LAST EXECUTION ADDRESS. EXCEPT RIGHT AFTER
    ENTERING OR LEAVING REAL TIME, THIS WILL RESULT ONLY IN A RETURN
    TO NACSYS. IN MOST CASES WHERE NUMERICAL DATA IS REQUESTED, THE
    OPERATOR MAY ERASE ANY PORTION OF AN UNCOMPLETED NUMBER AND START
    OVER BY TYPING IN A BACKSPACE.

    SINCE THE PROGRAM DATA REQUESTS ARE DEPENDENT UPON WHICH ROUTINE
    HAS BEEN CHOSEN, EACH SET OF REQUESTS MUST BE CONSIDERED SEPERATELY.
    THESE ROUTINES INCLUDE THE FOLLOWING:

(1) SITE.

NACSYS: SITE.

    SITE IS THE REQUEST THAT SITE INFORMATION (LATITUDE, LONGITUDE, AND
    ELEVATION ABOVE SEA LEVEL) BE ENTERED INTO MEMORY.

DESTINATION: SITE.A, B, OR C

    SITES A, B, AND C REFER TO REMOTE SITES AND CORRESPOND TO
    PUSHBUTTONS REMOTE A, REMOTE B, AND REMOTE C AT STATIONS 4 AND 5.

IDENTIFY: SITE NO.001 THRU 999

    THE SITE NUMBERS ARE CODES REPRESENTING THOSE SITES WHICH HAVE BEEN
    LISTED ON CARDS OR TAPE AND ARE AVAILABLE TO THE PROGRAM. THESE
    NUMBERS CANNOT BE LONGER THAN THREE DIGITS (NOT ALL ZEROS). NUMBERS
    OF LESS THAN THREE DIGITS SHOULD BE TERMINATED WITH A PERIOD.
    CORRECTIONS BY BACKSPACING ARE PERMITTED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

NOTE: WHEN A SITE IS BEING USED IN COMPUTATIONS PROGRAM TRACK
      OR FOR QUICK LOOK (CONTROLLED BY STATION 4), THE OPERATOR WILL BE
      NOTIFIED THAT THE SITE IS BEING PROCESSED AND REQUEST INFORMATION
      FOR SOME OTHER SITE.

(2) REFR.

NACSYS: REFR.

    REFR IS THE REQUEST THAT DATA ON ATMOSPHERIC REFRACTION AS A
    FUNCTION OF TRUE ELEVATION ANGLE BE ENTERED INTO MEMORY.

N(S) EQUATION = A

N(S) DIRECT   = B

N(S) STANDARD = C

METHOD (A, B, C):   A, B, OR C

    THE REPLY A, B, OR C WILL SELECT THE METHOD OF ENTRY FOR COMPUTING
    THE REFRACTIVITY, N(S). THESE METHODS INCLUDE COMPUTATION BY AN
    EQUATION FOR N(S), DIRECT ENTRANCE OF A VALUE FOR N(S), AND THE
    NATIONAL BUREAU OF STANDARDS RADIO PROPAGATION LABORATORY STANDARD
    FOR N(S) IN THE CONTINENTAL UNITED STATES. THE REQUESTS WHICH
    FOLLOW THE ABOVE REPLY WILL BE DETERMINED BY THE METHOD WHICH HAS .
    BEEN SELECTED. THE ALTERNATIVES ARE AS FOLLOWS:

(A) METHOD (A, B, C):   A

TEMPERATURE (DEG. F, C, OR K) = ---, ---.--, OR ---.-- E--

    THE AMBIENT TEMPERATURE OF THE ATMOSPHERE IS ENTERED BY THE OPERATOR
    AS AN INTEGER, A FIXED POINT NUMBER, OR A FLOATING POINT NUMBER OF
    VARIABLE LENGTH TERMINATED WITH AN F FOR DEGREES FARENHEIT, A C FOR
    DEGREES CENTIGRADE, OR A K FOR DEGREES KELVIN. THE UPPER AND LOWER
    TEMPERATURE LIMITS ARE 50 AND -30 DEGREES CENTIGRADE, RESPECTIVELY.
    IF THE TEMPERATURE IS OUTSIDE THE PERMITTED LIMITS, THE ROUTINE WILL
    REPLY WITH AN IMPRACTICAL DATA ERROR MESSAGE AND REQUEST THE
    TEMPERATURE AGAIN. CORRECTIONS BY BACKSPACING ARE PERMITTED.

PRESSURE (IN OR MM HG, OR MB) = ----, ----.--, OR ----.-- E--

    THE TOTAL ATMOSPHERIC PRESSURE IS ENTERED BY THE OPERATOR AS AN
    INTEGER, A FIXED POINT NUMBER, OR A FLOATING POINT NUMBER OF
    VARIABLE LENGTH TERMINATED WITH AN I FOR INCHES OF MERCURY, AN MM

FOR MILLIMETERS OF MERCURY, OR AN MB FOR MILLIBARS. THE UPPER AND
LOWER PRESSURE LIMITS ARE 1250 AND 750 MILLIBARS, RESPECTIVELY.
IF THE PRESSURE IS OUTSIDE THE PERMITTED LIMITS, THE ROUTINE WILL
REPLY WITH AN IMPRACTICAL DATA ERROR MESSAGE AND REQUEST THE
PRESSURE AGAIN. CORRECTIONS BY BACKSPACING ARE PERMITTED.

REL HUMIDITY (% OR DECIMAL ≠) = ---, ---.--, OR ---.-- E--

THE RELATIVE HUMIDITY OF THE ATMOSPHERE IS ENTERED BY THE OPERATOR
AS AN INTEGER, A FIXED POINT NUMBER, OR A FLOATING POINT NUMBER OF
VARIABLE LENGTH TERMINATED WITH A % FOR PERCENT AND A ≠ FOR A
DECIMAL FRACTION. THE UPPER AND LOWER LIMITS FOR THE RELATIVE
HUMIDITY ARE 100% AND 0%, RESPECTIVELY. IF THE RELATIVE HUMIDITY
IS OUTSIDE THE PERMITTED LIMITS, THE ROUTINE WILL REPLY WITH AN
IMPRACTICAL DATA ERROR MESSAGE AND REQUEST THE RELATIVE HUMIDITY
AGAIN. CORRECTIONS BY BACKSPACING ARE PERMITTED.

N(S) * = ---.--

THIS REPLY IS RETURNED TO THE TYPEWRITER BY THE PROGRAM AND IS THE
RESULT FOR N(S) OBTAINED BY THE EQUATION. THE MAXIMUM AND MINIMUM
N(S) ALLOWABLE ARE 500.00 AND 150.00, RESPECTIVELY. IF THE COMPUTED
VALUE FOR N(S) IS OUTSIDE THE PERMITTED LIMITS, THE PROGRAM WILL
REPLY WITH AN IMPRACTICAL DATA ERROR MESSAGE AND REQUEST METHOD
(A, B, C) AGAIN.

EXECUTED: --H --M --S

THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(B) METHOD (A, B, C):   B

N(S) * = ---, ---.--, OR ---.-- E--

A VALUE FOR N(S) IS ENTERED BY THE OPERATOR AS AN INTEGER, A FIXED
POINT NUMBER, OR A FLOATING POINT NUMBER OF VARIABLE LENGTH
TERMINATED WITH AN ASTERISK (*). THE UPPER AND LOWER LIMITS FOR
N(S) ARE 500 AND 150, RESPECTIVELY. IF N(S) IS OUTSIDE THE
PERMITTED LIMITS, THE ROUTINE WILL REPLY WITH AN IMPRACTICAL DATA
ERROR MESSAGE AND REQUEST METHOD (A, B, C) AGAIN. CORRECTIONS BY
BACKSPACING ARE ALLOWED.

EXECUTED: --H --M --S

THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(C) METHOD (A, B, C):   C

N(S) = 313.0

THIS REPLY IS RETURNED TO THE TYPEWRITER BY THE PROGRAM AND IS THE
NBS RADIO PROPAGATION LABORATORY STANDARD FOR N(S) IN THE
CONTINENTAL UNITED STATES.

EXECUTED: --H --M --S

THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(3) FREQ.

NACSYS: FREQ.

   FREQ PROVIDES THE MEANS OF ENTERING FREQUENCY DATA NECESSARY FOR
   COMPUTATIONS AND DISPLAYS AT STATIONS 4 AND 5 OF DOPPLER SHIFT AND
   FREE SPACE ANTENNUATION BETWEEN ISOTROPIC ANTENNAS.

DESTINATION: FREQ. 1, 2, OR 3

   ONLY ONE OF THESE NUMBERS IS TO BE USED. THESE NUMBERS ALSO
   CORRESPOND TO PUSHBUTTONS FREQ. 1, FREQ. 2, AND FREQ. 3 AT
   STATIONS 4 AND 5.

INPUT VIA: TYPE

MHZ OR GHZ: ----, ----.--, OR ----.-- E--

   THE FREQUENCY IS TYPED IN BY THE OPERATOR AS AN INTEGER, A FIXED
   POINT NUMBER, OR A FLOATING POINT NUMBER OF VARIABLE LENGTH
   TERMINATED WITH AN M FOR MEGAHERTZ OR A G FOR GIGAHERTZ. CORRECTION
   BY BACKSPACING IS PERMITTED.

EXECUTED: --H --M --S

   THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
   EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(4) ORBIT.

NACSYS: ORBIT.

   ORBIT IS THE REQUEST THAT ORBITAL DATA ON A SATELLITE BE ENTERED
   INTO MEMORY. NO TIME LIMITATIONS ARE PRESENT.

DESTINATION: S.1, 2, 3, OR 4

   THE REPLY CONSISTS OF THE DIGIT 1, 2, 3, OR 4. THESE DIGITS WILL
   DEFINE THE SATELLITE CHOSEN. MEMORY HAS BEEN ALLOCATED FOR THE
   ELEMENTS OF PERTURBATION ON FOUR SATELLITES.

IDENTIFY: CATALOG NO.----- OR ----.

   A SATELLITE IDENTIFICATION NUMBER OF LESS THAN FIVE DIGITS
   TERMINATED BY A PERIOD OR SIMPLY A FIVE DIGIT NUMBER IS ENTERED BY
   THE OPERATOR. ALL ZEROS ARE ILLEGAL.

CARD OR TAPE: C OR T

   THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
   THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

   THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
   EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

NOTE: IF THE DESTINATION 1, 2, 3, OR 4 IS BEING USED BY PROGRAM TRACK OR
      QUICK LOOK AND IF THE SAME DESTINATION IS REQUESTED BY ORBIT, THEN
      A DIAGNOSTIC AND AN EXIT TO DESTINATION WILL RESULT.

(5) PLANET.

NACSYS: PLANET.

    PLANET IS THE REQUEST THAT POSITION DATA FOR ONE OF THE PLANETS, THE
    SUN, OR THE MOON BE ENTERED INTO MEMORY. DATA FOR A 48 HOUR PERIOD
    WILL BE MADE AVAILABLE.

IDENTIFY: PLANET NO. 0 THRU 9

    THE REPLY IS A SINGLE DIGIT NUMBER DESIGNATING A PLANET, THE SUN, OR
    THE MOON.   THE CHOICES ARE:

            (0) SUN
            (1) MERCURY
            (2) VENUS
            (3) MOON
            (4) MARS
            (5) JUPITER
            (6) SATURN
            (7) URANUS
            (8) NEPTUNE
            (9) PLUTO

DESTINATION: C.1, C.2, OR M.1

    THIS REPLY CONSISTS OF THE DIGIT 1 OR 2. C.1 AND C.2 DEFINE THE
    SUN OR PLANET CHOSEN; WHEREAS, M.1 DEFINES THE MOON. MEMORY HAS
    BEEN ALLOCATED FOR DATA ON TWO CELESTIAL OBJECTS AND THE MOON.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S
    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS 00 MINUTES   00 SECONDS.

(6) SUN.

NACSYS: SUN.

    SUN IS THE REQUEST THAT POSITION DATA FOR THE SUN BE ENTERED INTO
    MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS). THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

   THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
   EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

(7) MERCURY.

NACSYS: MERCURY.

   MERCURY IS THE REQUEST THAT POSITION DATA FOR MERCURY BE ENTERED
   MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

   MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
   THE SUN, AND THE STARS). THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
   AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

   THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
   WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

   THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
   THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

   THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
   EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

(8) VENUS.

NACSYS: VENUS.

   VENUS IS THE REQUEST THAT POSITION DATA FOR VENUS BE ENTERED INTO
   MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

   MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
   THE SUN, AND THE STARS). THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
   AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

   THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
   WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

   THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
   THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

   THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
   EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

(9) MOON.

NACSYS: MOON.

    MOON IS THE REQUEST THAT POSITION DATA FOR THE MOON BE ENTERED INTO
MEMORY. DATA FOR A 12 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: M.1

    A SEPARATE SECTION OF MEMORY HAS BEEN ALLOCATED FOR MOON APART FROM
THE TWO BLOCKS RESERVED FOR CELESTIAL ORJECTS. SINCE NO OPERATOR
ACTION IS NECESSARY, THIS REPLY IS RETURNED BY THE ROUTINE.

START TIME: (MON/DAY/YR:HR)= --/--/--:-- OR NOW

    THIS REQUEST DEFINES THE DATE AND HOUR (EITHER NOW OR SOME OTHER
TIME) FOR WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(10) MARS.

NACSYS: MARS.

    MARS IS THE REQUEST THAT POSITION DATA FOR MARS BE ENTERED INTO
MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
THE SUN, AND THE STARS). THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(11) JUPITER.

NACSYS: JUPITER.

    JUPITER IS THE REQUEST THAT POSITION DATA ON JUPITER BE ENTERED INTO
MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS).   THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

(12) SATURN.

NACSYS: SATURN.

    SATURN IS THE REQUEST THAT POSITION DATA ON SATURN BE ENTERED INTO
    MEMORY.   DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS).   THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

(13) URANUS.

NACSYS: URANUS.

    URANUS IS THE REQUEST THAT POSITION DATA ON URANUS BE ENTERED INTO
    MEMORY.   DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS).   THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(14) NEPTUNE.

NACSYS: NEPTUNE.

    NEPTUNE IS THE REQUEST THAT POSITION DATA ON NEPTUNE BE ENTERED INTO
    MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS). THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(15) PLUTO.

NACSYS: PLUTO.

    PLUTO IS THE REQUEST THAT POSITION DATA ON PLUTO BE ENTERED INTO
    MEMORY. DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS). THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

(16) STAR.

NACSYS: STAR.

    STAR IS THE REQUEST THAT POSITION DATA ON A STAR BE ENTERED INTO
    MEMORY.   DATA FOR A 48 HOUR PERIOD WILL BE MADE AVAILABLE.

IDENTIFY: WSL CATALOG NO. ---- OR ---.

    A WALDORF STAR LIST NUMBER OF OF LESS THAN FOUR DIGITS TERMINATED
    BY A PERIOD OR SIMPLY A FOUR DIGIT NUMBER IS ENTERED BY THE
    OPERATOR.

DESTINATION: C.1 OR C.2

    MEMORY HAS BEEN ALLOCATED FOR TWO CELESTIAL OBJECTS (THE PLANETS,
    THE SUN, AND THE STARS).   THE NUMBER 1 OR 2 IS THE OPERATOR'S REPLY
    AND DEFINES THE CELESTIAL OBJECT C.1 OR C.2.

START TIME: (MON/DAY/YR)= --/--/-- OR NOW

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

CARD OR TAPE: C OR T

    THE SOURCE OF DATA INPUT IS DEFINED AS THE CARD READER BY C OR AS
    THE DATA FILES TAPE BY T.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

(17) LOOK.

NACSYS: LOOK.

    LOOK PROVIDES THE COMPUTATIONS AND LISTING OF DATA FOR TWO SITES.
    THE DATA INCLUDES THE DATE, TIME, AZIMUTH ANGLE, ELEVATION ANGLE,
    RANGE IN EARTH RADII, AND THE RANGE RATE IN HERTZ/GIGAHERTZ FOR ANY
    PREVIOUSLY DEFINED DATA SOURCE.

DATA SOURCE: -.-

    THE FORMAT FOR THE REPLY TO THE DATA SOURCE REQUEST IS A LETTER AND
    A NUMBER.   THE LETTER DESIGNATES THE TYPE OF SOURCE, AND THE NUMBER
    INDICATES WHICH OF THESE SOURCES YOU WISH TO EXTRACT FROM MEMORY.
    IF THE WORD ZERO IS TYPED IN, ANY DATA SOURCE REQUEST WILL BE
    REMOVED.   MEMORY HAS BEEN ALLOCATED FOR FOUR SATELLITES, THE MOON,
    AND TWO CELESTIAL OBJECTS.   THE POSSIBLE CHOICES INCLUDE
            S.1, S.2, S.3, OR S.4
            M.1
            C.1 OR C.2
            ZERO

PRIMARY: SITE.-

    POSSIBLE CHOICES FOR THE PRIMARY SITE ARE L FOR THE LOCAL SITE,
    A FOR REMOTE SITE A, B FOR REMOTE SITE B, OR C FOR REMOTE SITE C.

SECONDARY: SITE.-

    THE SAME CHOICES ARE AVAILABLE AS FOR THE PRIMARY SITE, WITH THE
    OPTION THAT IF A 0 (ZERO) IS TYPED IN, THE SECONDARY SITE DATA IS
    REMOVED ALTOGETHER.

START DATE: MON/DAY/YR= NOW OR --/--/--

    THIS REQUEST DEFINES THE DATE (EITHER NOW OR SOME OTHER DATE) FOR
    WHICH THE DATA IS DESIRED.

START TIME: HR MIN SEC= NOW OR -- -- --

    THE STARTING TIME DESIGNATES THE TIME (T=0) FOR THE FIRST COMPUTED
    VALUE OF ELEVATION, AZIMUTH, ETC.

INCR. TIME: HR MIN SEC= -- -- --

    THIS REFERS TO THE INCREMENT OF TIME BETWEEN EACH SUCCESSIVE VALUE
    IN THE COMPUTATIONS. A MAXIMUM INCREMENT OF 23 HOURS 59 MINUTES
    59 SECONDS MAY BE SELECTED. ALL ZEROS WILL RESULT IN ONLY ONE
    POINT OF DATA.

DATA POINTS = --. OR ---

    THE NUMBER OF DATA POINTS IS A SPECIFIED NUMBER OF NOT MORE THAN
    TWO DIGITS TERMINATED WITH A PERIOD OR SIMPLY BY A THREE DIGIT
    NUMBER (E.G., DATA POINTS = 50. OR 050). UP TO 999 DATA POINTS MAY
    BE REQUESTED. ALL ZEROS WILL LIST ONE DATA POINT. CORRECTION BY
    BACKSPACING IS PERMITTED.

OUTPUT UNIT = 0, 3, OR 4

    THIS IS A REQUEST FOR THE OPERATOR TO DEFINE THE OUTPUT UNIT ON
    WHICH THE DATA IS TO BE LISTED. ZERO (0) IS THE LINE PRINTER,
    THREE (3) IS TAPE UNIT 3, AND FOUR (4) IS TAPE UNIT 4. TAPE UNITS
    3 AND 4 MAY BE USED ONLY IF THEY CONTAIN TAPES WITH WRITE RINGS ON
    THEM. IT IS POSSIBLE TO REQUEST TAPE UNIT 2 BY REPLYING WITH A 2;
    BUT THIS IS CONSIDERED BAD PRACTICE SINCE THIS UNIT WILL BE USED
    FOR THE DATA FILES TAPE. TAPE UNIT 1 CONTAINS THE NACSYS MASTER
    TAPE AND WILL HANG UP THE SYSTEM IF REQUESTED.

NEED MORE (Y OR EXIT)=   Y OR EXIT

    EXIT WILL TERMINATE THE ROUTINE AND RETURN TO THE BEGINNING OF
    NACSYS, WHEREAS Y WILL YIELD A REQUEST FOR THE NUMBER OF ADDITIONAL
    DATA POINTS DESIRED.

EXECUTED: --H --M --S

    THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
    EXECUTED; E. G., AT 15 HOURS 00 MINUTES 00 SECONDS.

NOTE: IF THE DATA SOURCE REQUESTED BY LOOK IS BEING USED BY TRACK, A
    DIAGNOSTIC WILL RESULT. IF A PREMATURE TERMINATION OF THE DATA
    LISTING FROM LOOK IS DESIRED, DEPRESS JUMP KEY 2 ON THE COMPUTER
    CONSOLE, AND AN EXIT TO--NACSYS:--WILL BE EXECUTED. FOR A PAUSE
    IN THE LISTING ACTUATE JUMP KEY 1.

(18) TRACK.

NACSYS: TRACK.

    TRACK PROVIDES THE DATA FOR PROCESSING BY PROGRAM TRACK OR QUICK
    LOOK OF ANY OBJECT SPECIFIED BY THE DATA SOURCE AND AVAILABLE TO
    THE PROGRAM BY PREVIOUS DEFINITION.

DATA SOURCE: -.-

    THE FORMAT FOR THE REPLY TO THE DATA SOURCE REQUEST IS A LETTER AND
    A NUMBER. THE LETTER DESIGNATES THE TYPE OF SOURCE, AND THE NUMBER

INDICATES WHICH OF THESE SOURCES YOU WISH TO EXTRACT FROM MEMORY.
IF THE WORD ZERO IS TYPED IN, ANY DATA SOURCE REQUEST WILL BE
REMOVED.   MEMORY HAS BEEN ALLOCATED FOR FOUR SATELLITES, THE MOON,
AND TWO CELESTIAL OBJECTS.   THE POSSIBLE CHOICES INCLUDE
         S.1, S.2, S.3, OR S.4
         M.1
         C.1 OR C.2
         ZERO

EXECUTED: --H --M --S

THE COMPUTER WILL TYPE BACK THE GMT TIME AT WHICH THE PROGRAM WAS
EXECUTED; E. G., AT 15 HOURS   00 MINUTES   00 SECONDS.

NOTE: IF ANY OBJECT HAS BEEN DESIGNATED FOR SOURCE INFORMATION ON PROGRAM
      TRACK OR QUICK LOOK AND PROGRAM TRACK OR QUICK LOOK HAS BEEN
      PREVIOUSLY INITIATED, THEN THE SOURCE OBJECT WILL BE CHANGED AS
      REQUESTED AND THE PROGRAM WILL BE REINITIATED AS IF THE PROGRAM
      PUSHBUTTON AT STATION 5 HAD BEEN ACTUATED.

      ANOTHER RESTRICTION ON TRACK INVOLVES THE USE OF THE AUTOMATIC
      TRACKING MODE.   IF THE PROGRAM IS IN AUTO-TRACK MODE AND A REQUEST
      IS AGAIN MADE FOR TRACK, THE OPERATOR WILL RECEIVE THE REPLY--IN
      AUTO-TRACK MODE--AND AN EXIT BACK TO NACSYS.

(19) SERVOTST

NACSYS: SERVOTST

SERVOTST RECORDS AND STORES THE DIGITAL ERROR IN AZIMUTH OR
ELEVATION AND COMPUTES THE MEAN ERROR, RMS JITTER, RMS ERROR, AND
PEAK ERROR IN THE POSITION OF THAT AXIS.   THIS ROUTINE WILL OPERATE
ONLY IN DIGITAL MODE.

INITIATE SERVO TEST
TYPE AZ., ELEV., OR EXIT.

SERVO: AZ.***, ELEV.***, OR EXIT.

BY SELECTING AZ. OR ELEV., THE OPERATOR DESIGNATES WHICH AXIS IS TO
BE TESTED.   IMMEDIATELY UPON COMPLETION OF THE OPERATOR'S RESPONSE,
THE ROUTINE TYPES BACK *** AND BEGINS THE TEST.   RECORDING AND
STORING THE DIGITAL ERROR DATA REQUIRES ABOUT THIRTY-TWO SECONDS;
AFTER WHICH THE TYPEWRITER EXECUTES A CARRIAGE RETURN AND TYPES OUT
THE MEAN ERROR, RMS JITTER, RMS ERROR, AND PEAK ERROR.   THESE
COMPUTATIONS ARE BASED ON 4096 DATA POINTS.   TO LEAVE THIS ROUTINE,
THE REPLY EXIT MUST BE USED.

MEAN ERROR = -.---

MEAN ERROR = SUM (ERROR[I])/4096

RMS JITTER = -.---

RMS JITTER = SQRF (SUM (ERROR[I] - MEAN)**2/4096)

RMS ERROR = -.---

RMS ERROR = SQRF (SUM (ERROR[I])/4096)

PEAK ERROR = -.---

PEAK ERROR = MAX ABSL ERROR[I]

INTRINSIC ROUTINES

THE INTRINSIC ROUTINES ARE BASIC TO THE ENTIRE SYSTEM AND ARE COMPLETELY
SELF-CONTAINED. THEY MAY BE USED IN BOTH REAL TIME AND NON-REAL TIME
MODES OF OPERATION.

(1) EOF.U

    THIS ROUTINE SEARCHES FOR A DOUBLE END OF FILE MARK ON MAGNETIC TAPE
    UNIT U AND BACKSPACES OVER THE LAST ONE. IN MOST CASES, A DOUBLE
    END OF FILE MARK SIGNALS THE END OF THE LAST FILE OF INFORMATION ON
    THAT TAPE. BY BACKSPACING OVER THE LAST END OF FILE MARK, THE
    OPERATOR CAN ADD FILES TO A TAPE BY WRITING OVER THE THE SECOND
    EOF MARK.

(2) DUMP.U

    THIS ROUTINE DUMPS AVAILABLE MEMORY ONTO TAPE UNIT U. THE CONTENTS
    OF AVAILABLE MEMORY ARE NOT AFFECTED BY THIS ROUTINE.

(3) WRTE.U

    THIS ROUTINE WRITES BINARY RECORDS OF AN OPERATOR DEFINED SECTION OF
    MEMORY ON TAPE UNIT U. THE ROUTINE WILL REQUEST THE FIRST WORD
    ADDRESS (FWA= XXXXX) AND THE LAST WORD ADDRESS (LWA= XXXXX) OF THE
    SECTION OF MEMORY WHICH THE OPERATOR WISHES TO WRITE ON TAPE UNIT U.
    AN ADDRESS MAY BE WRITTEN AS AN OCTAL NUMBER OF LESS THAN FIVE OCTAL
    PLACES TERMINATED WITH A PERIOD OR SIMPLY A FIVE PLACE OCTAL NUMBER
    (E.G., FWA= 100. AND LWA= 777. OR FWA= 00100 AND LWA= 00777).

(4) MARK.U

    THIS ROUTINE WRITES TWO END OF FILE MARKS ON TAPE UNIT U AND
    BACKSPACES OVER THE LAST ONE.

(5) RCVR.U

    THIS ROUTINE RECOVERS AN AVAILABLE MEMORY DUMP (REQUESTED BY DUMP.U)
    FROM TAPE UNIT U. THE CONTENTS OF TAPE UNIT U ARE NOT AFFECTED BY
    THIS ROUTINE.

(6) READ.U

    THIS ROUTINE READS BINARY RECORDS FROM TAPE UNIT U INTO AN OPERATOR
    DEFINED SECTION OF MEMORY. THE ROUTINE WILL REQUEST THE FIRST WORD
    ADDRESS (FWA= XXXXX) AND THE LAST WORD ADDRESS (LWA= XXXXX) FOR THE
    SECTION OF MEMORY INTO WHICH THE BINARY RECORDS WILL BE READ.
    AN ADDRESS MAY BE WRITTEN AS AN OCTAL NUMBER OF LESS THAN FIVE OCTAL
    PLACES TERMINATED WITH A PERIOD OR SIMPLY A FIVE PLACE OCTAL NUMBER
    (E.G., FWA= 100. AND LWA= 777. OR FWA= 00100 AND LWA= 00777).

(7) ADV.U/XXX

    THIS ROUTINE ADVANCES XXX RECORDS ON TAPE UNIT U UNLESS AN END OF
    FILE MARK IS ENCOUNTERED. IF ONE IS ENCOUNTERED, THE TAPE WILL
    STOP; AND THE ROUTINE WILL RESPOND WITH ***EOF/YYY. THIS REPLY
    MEANS THAT THE TAPE HAS ADVANCED YYY RECORDS (NOT INCLUDING THE END
    OF FILE MARK) AND IS POSITIONED AT THE BEGINNING OF THE NEXT FILE.

(8) REV.U/XXX

> THIS ROUTINE BACKSPACES XXX RECORDS ON TAPE UNIT U UNLESS AN END OF
> FILE MARK OR A LOAD POINT IS ENCOUNTERED. IF AN END OF FILE MARK
> IS ENCOUNTERED, THE TAPE WILL STOP ; AND THE ROUTINE WILL RESPOND
> WITH ***EOF/YYY.   IF A LOAD POINT IS ENCOUNTERED, THE TAPE WILL
> STOP; AND THE ROUTINE WILL RESPOND WITH **LDPT/YYY.   THE REPLYS MEAN
> THAT THE TAPE HAS BACKSPACED YYY RECORDS (NOT INCLUDING THE END OF
> FILE MARK) AND IS POSITIONED AT THE BEGINNING OF THE NEXT FILE.

(9) RWND.U

> THIS ROUTINE REWINDS TAPE UNIT U.

(10) BACK.U/XXX

> THIS ROUTINE BACKS UP TO THE BEGINNING OF THE FILE XXX FILES PRIOR
> TO THE PRESENT FILE ON TAPE UNIT U. FOR XXX= 000, THE ROUTINE WILL
> BACKSPACE TAPE UNIT U TO THE BEGINNING OF THE PRESENT FILE. IF A
> LOAD POINT IS ENCOUNTERED, THE TAPE WILL STOP; AND THE ROUTINE WILL
> RESPOND WITH **LDPT/YYY. THIS REPLY MEANS THAT THE TAPE HAS MOVED
> BACK YYY FILES.

(11) STEP.U/XXX

> THIS ROUTINE MOVES FORWARD TO THE BEGINNING OF THE FILE XXX FILES
> FOLLOWING THE PRESENT FILE ON TAPE UNIT U. FOR XXX=000, THE ROUTINE
> WILL PROCEED TO THE END OF THE PRESENT FILE.

(12) LOAD.U

> THIS ROUTINE LOADS BINARY CARD IMAGES FROM TAPE UNIT U INTO AN
> OPERATOR DESIGNATED SECTION OF MEMORY. THE ROUTINE WILL REQUEST
> THE FIRST WORD ADDRESS (FWA= XXXXX) AND THE LAST WORD ADDRESS
> (LWA= XXXXX) FOR THE SECTION OF MEMORY INTO WHICH THE CARD IMAGES
> WILL BE READ. AN ADDRESS MAY BE WRITTEN AS AN OCTAL NUMBER OF LESS
> THAN FIVE PLACES TERMINATED WITH A PERIOD OR SIMPLY A FIVE PLACE
> OCTAL NUMBER (E.G., FWA= 100. AND LWA= 777. OR FWA= 00100 AND
> LWA= 00777). THIS ROUTINE REQUIRES PRIOR POSITIONING OF THE TAPE.

(13) LIST.U

> THIS ROUTINE LISTS LINE IMAGES FROM TAPE UNIT U TO THE LINE PRINTER.
> PRIOR POSITIONING IS REQUIRED.

(14) RSET.

> THIS ROUTINE SETS THE HI DENSITY MODE AND REWINDS ALL OF THE TAPES.

(15) DATE.XX/XX/XX

> THIS ROUTINE ENTERS THE DATE AS A REFERENCE FOR THE OPERATOR. THE
> FORMAT MONTH/DAY/YEAR IN THE FORM XX/XX/XX MUST BE USED. THIS
> ROUTINE DOES NOT AFFECT THE DATE IN THE NACTAC PROGRAM.

(16) ZERO.

> THIS ROUTINE ZEROS ALL AVAILABLE MEMORY, SETS (NEXT)=(LOWER), AND
> TYPES OUT THE AREA ZEROED.

(17) XEQ.MMMMM

ONLY OPERATORS FAMILIAR WITH THIS ROUTINE WILL BE ALLOWED TO USE IT.
THIS ROUTINE CLEARS ALL OF THE REGISTERS IN THE COMPUTER AND
EXECUTES AN SLS   KI   MMMMM (OR, FOR REAL TIME OPERATION, A
UJP   MMMMM).

NOTE.....   00000=BOTTOM OF AVAILABLE MEMORY
            77777=TOP OF AVAILABLE MEMORY
            .=NEXT AVAILABLE ADDRESS
            /=LAST EXECUTION ADDRESS

(18) NEXT.

THIS ROUTINE WILL TYPE OUT THE NEXT AVAILABLE ADDRESS.

(19) RANG.

THIS ROUTINE WILL TYPE OUT THE RANGE OF AVAILABLE MEMORY.

(20)   .   (A SINGLE PERIOD)

A SINGLE PERIOD, SPACES ONLY FOLLOWED BY A PERIOD, OR EIGHT SPACES
ONLY WILL CAUSE A JUMP TO THE LAST EXECUTION ADDRESS.   EXCEPT
RIGHT AFTER ENTERING OR LEAVING REAL TIME, THIS WILL RESULT ONLY
IN A RETURN TO NACSYS.

CONSOLE SWITCHES AND DISPLAYS

STATION 4 AND 5 PANELS ARE COMPRISED OF LIGHTED PUSHBUTTON SWITCHES,
THUMBWHEEL SWITCHES, AND IN-LINE DISPLAYS.   THE LIGHTED PUSHBUTTON
SWITCHES (WITH THE EXCEPTION OF THE REAL TIME CLOCK CONTROL GROUP ON
THE STATION 5 PANEL) DO NOT PROVIDE DIRECT CONTROL OVER ANY INTERFACE
HARDWARE.   THE ACTUATION OF THESE SWITCHES IS SENSED BY THE SOFTWARE
PROGRAM TO WHICH THE COMPUTER RESPONDS WITH SOFTWARE CONTROL OF THE
ASSOCIATED LIGHT.

THE LIGHTED PUSHBUTTON SWITCHES AND THEIR ASSOCIATED THUMBWHEEL SWITCHES
AND IN-LINE DISPLAYS WILL BE GROUPED ACCORDING TO THE FUNCTIONS WHICH
THEY PERFORM.   THESE GROUPS ARE DEFINED AS FOLLOWS:

GROUP	STATION	PUSHBUTTON
	5	CLEAR
	5	DESIGNATE AZ-EL
GROUP 1	5	PROGRAM
	5	DIGITAL SLAVE
	5	DESIGNATE RA-DEC
	5	CLEAR
	5	ELLIPTICAL
GROUP 2	5	SPIRAL
	5	HOLD
	5	CONTINUE
	5	TIME OFFSET CLEAR
GROUP 3	5	ADD
	5	SUBTRACT

GROUP	STATION	PUSHBUTTON
GROUP 4	5	AZIMUTH OFFSET CLEAR
	5	ADD
	5	SUBTRACT
GROUP 5	5	ELEVATION OFFSET CLEAR
	5	ADD
	5	SUBTRACT
GROUP 6	4, 5	CLEAR
	4, 5	EARTH RADII-CPS/GC
	4, 5	FREQUENCY 1
	4, 5	FREQUENCY 2
	4, 5	FREQUENCY 3
GROUP 7	4, 5	CLEAR
	4, 5	REMOTE A
	4, 5	REMOTE B
	4, 5	REMOTE C
	4, 5	ADD LOCAL
GROUP 8	4	CLEAR
	4	SET
	4	HOLD
	4	INCREASE
	4	DECREASE

THE PUSHBUTTON SWITCHES CONTAINED WITHIN ANY ONE GROUP PERFORM RELATED
FUNCTIONS OF CONTROL OR SELECTION AND MAY HAVE ASSOCIATED WITH THEM
THUMBWHEEL SWITCHES FOR DESIGNATING SOME PARAMETER AND/OR IN-LINE
DISPLAY FOR OPERATOR OBSERVATION OF PROGRAM COMPUTATIONS.

GROUPS 1-7 FUNCTION ONLY IN DIGITAL MODE (SELECTED AT STATION 5).
IF DIGITAL MODE IS SELECTED, EITHER DESIGNATE AZ-EL, PROGRAM, DIGITAL
SLAVE, OR DESIGNATE RA-DEC MUST BE ACTIVATED. THIS IS NECESSARY SINCE
GROUPS 1 THROUGH 7 WILL NOT OPERATE IF GROUP 1 IS CLEARED. IN ADDITION,
GROUPS 1 THROUGH 7 WILL FUNCTION ONLY IN CERTAIN SEQUENCES. WHEN NOT
FUNCTIONING, GROUPS 1 THROUGH 7 WILL BE CLEARED.

GROUP 8, ON THE OTHER HAND, FUNCTIONS ONLY IN NOT-DIGITAL MODE;
I. E., WHEN DIGITAL MODE IS SELECTED, GROUP 8 WILL BE AUTOMATICALLY
CLEARED. GROUP 8 WILL BE USED FOR QUICK LOOK.

THE AZIMUTH AND ELEVATION DISPLAYS GIVE COMPUTATIONS 16 TIMES PER SECOND.
THE LOCAL AND REMOTE RANGE AND RANGE RATE DISPLAYS GIVE COMPUTATIONS ONCE
PER SECOND.

ALL OPERATIONS INVOLVING PUSHBUTTON CONTROL ARE FAIL-SAFE; I. E., IF THE
OPERATOR ATTEMPTS TO INITIATE ACTION OUT OF CORRECT SEQUENCE OR IF
CERTAIN ELEMENTS HAVE NOT BEEN PROPERLY DEFINED, EITHER NOTHING HAPPENS
OR A FLASHBACK IS RETURNED BY THE PUSHBUTTON.

GROUP 1

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.

B. DESIGNATE AZ-EL

THE DESIGNATE AZ-EL PUSHBUTTON WILL DESIGNATE THE ELEVATION ANGLE
(WITH RESPECT TO THE PLANE TANGENT TO THE GEOIDAL ELLIPSE) AND THE

AZIMUTH ANGLE AT THE LOCAL SITE AS DEFINED BY THE ANGLE DESIGNATE
THUMBWHEEL SWITCHES AT STATION 5. IN GENERAL, THE ANTENNA AZIMUTH AND
ELEVATION POINTING ANGLES WILL NOT BE THE SAME AS THE DESIGNATED ANGLES
UNLESS NO CAM CORRECTIONS HAVE BEEN PROVIDED; I. E., UNLESS PROGRAM
NUMBER XXI HAS BEEN SELECTED.

GROUP 2 ELLIPTICAL AND SPIRAL SCANS ARE PERMITTED IN THE DESIGNATE AZ-EL
MODE AND ARE CENTERED ABOUT A FIXED POSITION DEFINED BY THE DESIGNATED
ANGLES. SEE GROUP 2 FOR DETAILED EXPLANATIONS.

GROUPS 3, 4, 5, 6, AND 7 ARE NOT PERMITTED IN THE DESIGNATE AZ-EL MODE,
AND ACTUATING PUSHBUTTONS IN THESE GROUPS WILL CAUSE NO ACTION.

ELEVATION IS ENTERED VIA THE ELEVATION DESIGNATE THUMBWHEEL SWITCH AT
STATION 5 AND CONSISTS OF A SIGNED FIVE PLACE NUMBER WITH THREE PLACES
AFTER THE DECIMAL POINT. ANGLES FROM -99.999 TO +99.999 DEGREES CAN BE
DESIGNATED ALTHOUGH ELEVATION LIMITS ARE DEFINED BY THE PROGRAM FOR THE
DESIGNATE AZ-EL MODE.

AZIMUTH IS ENTERED VIA THE AZIMUTH DESIGNATE THUMBWHEEL SWITCH AT STATION
5 AND CONSISTS OF ZONES A THROUGH D FOLLOWED BY A SIX PLACE NUMBER WITH
THREE PLACES AFTER THE DECIMAL POINT. ANGLES FROM A000.000 THROUGH
D399.999 CAN BE ENTERED ALTHOUGH AZIMUTH LIMITS ARE DEFINED BY THE
PROGRAM FOR THE DESIGNATE AZ-EL MODE. THE AZIMUTH ZONES ARE DEFINED AS
FOLLOWS:

ZONE A RANGES FROM -450.000 TO -360.000 DEGREES
ZONE B RANGES FROM -359.999 TO -000.001 DEGREES
ZONE C RANGES FROM 000.000 TO +359.999 DEGREES
ZONE D RANGES FROM +360.000 TO +450.000 DEGREES

THE NUMBER WHICH FOLLOWS THE ZONE IS A POSITIVE ANGLE BETWEEN 0 AND 360
DEGREES AND LIES IN THE QUADRANT DEFINED BY THE ZONE; E. G., A315.000
IS -45.000 DEGREES AND D045.000 IS +405.000 DEGREES

ROUTINE TRACK. THE PROGRAM MODE IS FUNCTIONAL ONLY IF TRACK (1) HAS
BEEN EXECUTED, (2) IS PROCESSING THE DATA SOURCE, AND (3) IS WITHIN
THE PROGRAM LIMITS FOR ANTENNA POSITION.

GROUPS 2, 3, 4, 5, 6, AND 7 ARE PERMITTED IN PROGRAM (TRACK) MODE.
WHENEVER PROGRAM MODE IS RE-INITIATED, GROUPS 2,3,4,5,6, AND 7 WILL BE
CLEARED AUTOMATICALLY.

IN GROUP 2, ONLY SPIRAL SCAN, HOLD, AND CONTINUE ARE PERMITTED IN
PROGRAM MODE. THE SPIRAL SCAN IS OF THE FORM OF A SPIRAL OF ARCHIMEDES,
WHERE THE SCAN PARAMETERS ARE INITIALLY ENTERED BY THE OPERATOR. FOR
COMPLETE DETAILS ON PROGRAM MODE SCANS SEE GROUP 2.

A TIME OFFSET (DESIGNATED BY THE TIME OFFSET THUMBWHEEL SWITCH AT
STATION 5) MAY BE ENTERED BY THE ADD-SUBTRACT PUSHBUTTONS IN GROUP 3.
AN OFFSET UP TO 7 MINUTES 59.999 SECONDS MAY BE ADDED TO OR SUBTRACTED
FROM THE GMT TIME.

AN AZIMUTH OFFSET (DESIGNATED BY THE AZIMUTH OFFSET THUMBWHEEL SWITCH AT
STATION 5) MAY BE ENTERED BY THE ADD-SUBTRACT PUSHBUTTONS IN GROUP 4.
AN OFFSET UP TO 99.999 DEGREES MAY BE ADDED TO OR SUBTRACTED FROM THE
AZIMUTH ANGLE.

AN ELEVATION OFFSET (DESIGNATED BY THE ELEVATION OFFSET THUMBWHEEL AT
STATION 5) MAY BE ENTERED BY THE ADD-SUBTRACT PUSHBUTTONS IN GROUP 5.
AN OFFSET UP TO 99.999 DEGREES MAY BE ADDED TO OR SUBTRACTED FROM THE
ELEVATION ANGLE.

PROGRAM LIMITS FOR ANTENNA POSITION ARE -00.00 AND +90.00 DEGREES FOR
ELEVATION AND A315.000 AND D045.000 DEGREES (I. E., -405.000 AND +405.000
DEGREES, RESPECTIVELY) FOR AZIMUTH.

IF A STARTING POSITION OUTSIDE OF THE ANTENNA LIMITS IS REQUESTED BY
PROGRAM TRACK IN CONJUNCTION WITH A PROGRAM NUMBER OXX THROUGH 4XX, THE
ANTENNA WILL HOLD AT ITS PRESENT POSITION AND RETURN A FLASHBACK TO THE
PROGRAM (TRACK) PUSHBUTTON.

IF THE ANTENNA LIMITS ARE REACHED WHILE PROGRAM TRACK IS PROCESSING THE
DATA SOURCE, THE ANTENNA WILL HOLD AND RETURN A FLASHBACK TO THE PROGRAM
(TRACK) PUSHBUTTON.

IF INSUFFICIENT DATA IS AVAILABLE TO A CELESTIAL DATA SOURCE, PROGRAM
TRACKING WILL TERMINATE AFTER THE LAST DATA POINT, THE ANTENNA WILL HOLD,
AND A FLASHBACK WILL BE RETURNED ON ALL OF THE SELECTED PUSHBUTTON
SWITCHES EXCEPT THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM
(TRACK) DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL
IGNORE THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM (TRACK) DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

PROGRAM NUMBER OXX WILL SELECT AUTO-ACQUISITION, NO PROGRAM RETENSION.
PROGRAM NUMBER IXX WILL SELECT AUTO-ACQUISITION, PROGRAM RETENSION.
PROGRAM NUMBER 2XX WILL SELECT UNCOND. ACQUISITION, NO PROGRAM RETENSION.
PROGRAM NUMBER 3XX WILL SELECT UNCOND. ACQUISITION, PROGRAM RETENSION.
PROGRAM NUMBER 4XX WILL SELECT PROGRAM CORRECT CONTROL.

PROGRAM NUMBER 5XX HAS NO MEANING IN PROGRAM (TRACK) MODE.
PROGRAM NUMBER 6XX WILL SELECT LIMIT HOLD.
PROGRAM NUMBER 7XX WILL SELECT SCAN OFFSET CONTROL.

D. DIGITAL SLAVE

PRESENTLY THIS MODE IS NOT DEFINED; BUT WHEN IT IS DEFINED, GROUPS 2, 4,
AND 5 WILL BE FUNCTIONAL. IN GROUP 2, ONLY SPIRAL SCAN, HOLD, AND
CONTINUE WILL BE PERMITTED IN DIGITAL SLAVE MODE.

E. DESIGNATE RA-DEC

THE DESIGNATE RA-DEC PUSHBUTTON WILL DESIGNATE THE RIGHT ASCENSION AND
DECLINATION OF A POINT ON THE CELESTIAL SPHERE (REFERRED TO THE CENTER
OF THE GEOIDAL ELLIPSE).

GROUP 2 ELLIPTICAL AND SPIRAL SCANS ARE PERMITTED IN THE DESIGNATE RA-DEC
MODE AND ARE CENTERED ABOUT A FIXED POSITION DEFINED BY THE DESIGNATED
ANGLES. SEE GROUP 2 FOR DETAILED EXPLANATIONS.

GROUPS 3, 4, 5, 6, AND 7 ARE NOT PERMITTED IN THE DESIGNATE RA-DEC MODE,
AND ACTUATING PUSHBUTTONS IN THESE GROUPS WILL CAUSE NO ACTION.

DECLINATION IS ENTERED VIA THE ELEVATION DESIGNATE THUMBWHEEL SWITCH AT
STATION 5 AND CONSISTS OF A SIGNED FIVE PLACE NUMBER WITH THREE PLACES
AFTER THE DECIMAL POINT. ANGLES FROM -99.999 TO +99.999 DEGREES CAN BE
DESIGNATED ALTHOUGH ANTENNA LIMITS ARE DEFINED BY THE PROGRAM FOR THE
DESIGNATE RA-DEC MODE.

RIGHT ASCENSION IS ENTERED VIA THE AZIMUTH DESIGNATE THUMBWHEEL SWITCH
AT STATION 5. THE ZONE PORTION OF THE DESIGNATE SWITCH IS MEANINGLESS IN
THE DESIGNATE RA-DEC MODE AND SHOULD BE DISREGARDED. ANGLES FROM 000.000
TO 399.999 DEGREES CAN BE ENTERED ALTHOUGH ANTENNA LIMITS ARE DEFINED BY
THE PROGRAM FOR THE DESIGNATE RA-DEC MODE.

PROGRAM LIMITS FOR ANTENNA POSITION ARE -00.00 AND +90.00 DEGREES FOR
ELEVATION AND A315.000 AND D045.000 DEGREES (I. E., -405.000 AND +405.000
DEGREES, RESPECTIVELY) FOR AZIMUTH.

IF A POSITION OUTSIDE OF THE PERMITTED PROGRAM LIMITS IS DESIGNATED FOR
PROGRAM NUMBERS OXX THROUGH 4XX, THE ANTENNA WILL HOLD AT ITS PRESENT
POSITION AND RETURN A FLASHBACK TO THE DESIGNATE RA-DEC PUSHBUTTON.

IF A POSITION OUTSIDE OF THE PERMITTED PROGRAM LIMITS IS DESIGNATED IN
CONJUNCTION WITH PROGRAM NUMBER 6XX, THE ANTENNA WILL MOVE UNTIL THE
PROGRAM LIMITS ARE ENCOUNTERED AND THEN HOLD.

IN SELECTING PROGRAM NUMBERS FOR THE DESIGNATE RA-DEC MODE, ALL REFERENCE
TO PROGRAM CONTROL OR RETENTION IS OF NO MEANING. IN THESE CASES, ONLY
THE MODE OF ACQUISITION AND THE PROGRAM POSITION LIMITS ARE USED. THUS,
IN THE DESIGNATE RA-DEC MODE, PROGRAM NUMBERS OXX AND IXX SELECT AUTO-
ACQUISITION, AND PROGRAM NUMBERS 2XX THROUGH 4XX SELECT UNCONDITIONAL
ACQUISITION, PROGRAM NUMBER 6XX SELECTS UNCONDITIONAL ACQUISITION WITH
LIMIT HOLD, AND PROGRAM NUMBER 7XX SELECTS SCAN OFFSET CONTROL. PROGRAM
NUMBER 5XX HAS NO MEANING IN DESIGNATE RA-DEC MODE.

GROUP 2

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.
IF PROGRAM NUMBER 7XX IS BEING USED IN CONJUNCTION WITH ANY NON-CLEAR

SCAN MODE (GROUP 2), CLEARING THIS GROUP WILL RECENTER THE SCAN AROUND
THE LAST ANTENNA POSITION AND WILL AUTOMATICALLY ENTER THE AZIMUTH AND
ELEVATION OFFSETS OR ADD THEM TO ANY EXISTING OFFSETS.

B. ELLIPTICAL (SCAN)

THE ELLIPTICAL (SCAN) PUSHBUTTON SELECTS ELLIPTICAL SCANNING IN
CONJUNCTION WITH THE DESIGNATE AZ-EL OR DESIGNATE RA-DEC MODE IN GROUP 1.
THE PARAMETERS OF THE ELLIPSE--THE SHAPE, AMPLITUDE, AND RATE--ARE
ENTERED THROUGH THE SCAN PARAMETER THUMBWHEEL SWITCHES AT STATION 5.
THE VELOCITY OF THE POINT BEING TRACKED IS ENTERED IN POLAR COORDINATE
FORM THROUGH THE VELOCITY DESIGNATE THUMBWHEEL SWITCH AT STATION 5.
THE ELLIPSE WILL INITIALLY BE CENTERED ON THE DESIGNATE COMMAND.

THE SHAPE OF THE ELLIPSE IS DEFINED BY THE SCAN PARAMETER THUMBWHEEL
SWITCH AT STATION 5. THE SHAPE IS EQUAL TO THE RATIO OF THE MINOR AXIS
TO THE MAJOR AXIS AND IS A NUMBER BETWEEN .00 AND .99, WHERE .00 IS A
LINE AND .99 IS A CIRCLE. THE SHAPE OF THE SCAN IS REFERRED TO LINEAR
AZIMUTH AND ELEVATION SCALES; HOWEVER, IN PRACTICE THE SCANS ARE
DISTORTED AS A RESULT OF EFFECTIVE CHANGES IN THE AZIMUTH AND ELEVATION
SCALES.

THE AMPLITUDE OF THE ELLIPSE IS DEFINED BY THE SCAN PARAMETER THUMBWHEEL
SWITCH AT STATION 5. THE AMPLITUDE EQUALS THE LENGTH OF THE SEMI-MAJOR
AXIS AND IS A NUMBER BETWEEN 0.0 AND 9.9 DEGREES.

THE RATE OF THE ELLIPTICAL SCAN IS DEFINED BY THE SCAN PARAMETER
THUMBWHEEL SWITCH AT STATION 5. THE RATE IS EQUAL TO THE FRACTION OF THE
MAXIMUM PERMITTED SCAN RATE AND IS A NUMBER BETWEEN .00 AND .99.

THE INCLINATION OF THE MAJOR AXIS OF THE ELLIPSE TO THE HORIZONTAL AXIS
IS INDIRECTLY DEFINED BY THE VELOCITY DESIGNATE THUMBWHEEL SWITCH AT
STATION 5. THE INCLINATION OF THE MAJOR AXIS TO THE HORIZONTAL AXIS IS
EQUAL TO THE INCLINATION OF THE VELOCITY DESIGNATE VECTOR TO THE
HORIZONTAL AXIS PLUS 90 DEGREES. THE MAGNITUDE OF THE VELOCITY IS A
NUMBER BETWEEN 0.00 AND 9.99 DEGREES/SECOND; THE DIRECTION WITH RESPECT
TO THE HORIZONTAL AXIS IS A NUMBER BETWEEN 000 AND 399 DEGREES.

NEW SCAN PARAMETERS MAY BE ENTERED AT ANY TIME BY RESETTING THE
THUMBWHEEL SWITCHES AND DEPRESSING THE ELLIPTICAL (SCAN) PUSHBUTTON.

WHENEVER NEW SCANS ARE INITIATED, THE PROGRAM TAKES THE COURSE OF LEAST
ACTION; I. E., THE NEW SCAN WILL START AT THE POSITION NEAREST TO THE   .
LAST POSITION OF THE PREVIOUS SCAN.

ACTUATING THE HOLD PUSHBUTTON WILL STOP AND HOLD THE SCAN AT ITS PRESENT
POSITION, WHEREAS THE CONTINUE PUSHBUTTON WILL RESTART THE SCAN FROM THAT
POSITION WITH NO CHANGE IN SCAN PARAMETERS.

IF PROGRAM NUMBER 7XX IS BEING USED IN CONJUNCTION WITH ANY NON-CLEAR
SCAN MODE (GROUP 2), CLEARING THIS GROUP WILL RECENTER THE SCAN AROUND
THE LAST ANTENNA POSITION AND WILL AUTOMATICALLY ENTER THE AZIMUTH AND
ELEVATION OFFSETS OR ADD THEM TO ANY EXISTING OFFSETS.

IF LIMIT HOLD (PROGRAM NUMBER 6XX FOR DESIGNATE AZ-EL MODE ONLY) HAS BEEN
SELECTED AND THE ANTENNA AZIMUTH AND/OR ELEVATION LIMITS ARE NOT
CONSISTENT WITH THE SCAN PARAMETERS, THE ANTENNA WILL MOVE UNTIL THE
PROGRAM LIMITS ARE ENCOUNTERED AND THEN HOLD.

IF AZIMUTH AND/OR ELEVATION LIMITS CONFLICT WITH THE SCAN PARAMETERS,
THE PROGRAM WILL DISTORT THESE PARAMETERS TO CONFORM WITH THE LIMITS.

AUTOMATIC AQUISITION, ELLIPTICAL SCAN, DEFINED BY PROGRAM NUMBERS 0XX
AND 1XX, PROCEEDS IN THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS AND VELOCITY DESIGNATE
    THROUGH THE THUMBWHEEL SWITCHES AT STATION 5. IN ADDITION, THE
    OPERATOR MUST ACTUATE THE ELLIPTICAL (SCAN) AND ONE OF THE DESIGNATE
    PUSHBUTTONS. IF NO SCAN HAS BEEN SELECTED, BEHAVIOR UPON ACQUISITION
    IS THE SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) THE OPERATOR SELECTED ELLIPTICAL SCAN WILL INITIALLY BE CENTERED ON
    THE DESIGNATE COMMAND.

(4) THE ELLIPTICAL SCAN WILL STOP WHEN A MOMENTARY ACQUISITION IS
    OBTAINED, AND A PROGRAM CONTROLLED SPIRAL SCAN WILL BE INITIATED AT
    THE POINT OF MOMENTARY ACQUISITION. WHEN THE NEW SCAN IS INITIATED
    AT THE POINT OF MOMENTARY ACQUISITION, AZIMUTH AND ELEVATION
    OFFSETS WILL BE ENTERED BY THE PROGRAM (OR ADDED TO PERVIOUS OFFSETS)
    SO AS TO CORRESPOND TO THE CHANGE OF CENTER. IN ADDITION, THE CENTER
    OF THE SPIRAL SCAN WILL MOVE IN THE DIRECTION OF THE VELOCITY VECTOR
    WITH A VELOCITY DETERMINED BY THE MAGNITUDE OF THAT VECTOR. NO
    ATTEMPT IS YET MADE FOR AUTOMATIC TRACKING. IF ANOTHER MOMENTARY
    ACQUISITION IS OBTAINED WHILE IN PROGRAM CONTROLLED SPIRAL SCAN, A
    NEW SCAN IS INITIATED ABOUT THAT POINT OF MOMENTARY ACQUISITION.

(5) IF ACQUISITION IS SUSTAINED FOR MORE THAN ONE SECOND AFTER A
    MOMENTARY ACQUISITION, AUTOMATIC TRACKING MODE IS INITIATED.

(6) IF, ON THE OTHER HAND, NO FURTHER ACQUISITION IS MADE, THE ELLIPTICAL
    SCAN IS RESUMED AFTER THE PROGRAM DEFINED SPIRAL HAS EXPANDED TO ITS
    MAXIMUM AMPLITUDE. THE NEW ELLIPTICAL SCAN WILL BE RECENTERED ABOUT
    A POINT TEN SECONDS AHEAD OF THE LAST CENTER IN THE DIRECTION OF THE
    VELOCITY VECTOR.

(7) WHEN ACQUISITION IS LOST AFTER AUTOMATIC TRACKING MODE HAS BEEN
    INITIATED, THE PROGRAM GOES INTO RATE MEMORY. IF THE SIGNAL GOES
    ABOVE THRESHOLD DURING RATE MEMORY, AUTOMATIC TRACKING IS
    REINITIATED. IF RATE MEMORY TERMINATES AFTER APPROXIMATELY ONE
    MINUTE, SCAN PROCEDURES MUST BE REINITIATED BY THE OPERATOR. THE
    TIME FOR RATE MEMORY AND THE PROGRAM CONTROLLED SCAN PARAMETERS WILL
    BE DIFFERENT FOR RECEIVERS 1 AND 2.

UNCONDITIONAL ACQUISITION, ELLIPTICAL SCAN, DEFINED BY PROGRAM NUMBERS
2XX THROUGH 6XX, PROCEEDS IN THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS AND VELOCITY DESIGNATE
    THROUGH THE THUMBWHEEL SWITCHES AT STATION 5. IN ADDITION, THE
    OPERATOR MUST ACTUATE THE ELLIPTICAL (SCAN) AND ONE OF THE DESIGNATE
    PUSHBUTTONS. IF NO SCAN HAS BEEN SELECTED, BEHAVIOR UPON ACQUISITION
    IS THE SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) THE OPERATOR SELECTED ELLIPTICAL SCAN WILL INITIALLY BE CENTERED ON
    THE DESIGNATE COMMAND.

(4) THE ELLIPTICAL SCAN WILL PROCEED UNTIL A MOMENTARY ACQUISITION IS
    OBTAINED. UPON MOMENTARY ACQUISITION, THE PROGRAM IMMEDIATELY
    ATTEMPTS ACQUISITION. IF ACQUISITION IS NOT ACCOMPLISHED, THE SCAN
    WILL HOLD AT ITS PRESENT POSITION. OPERATOR CONTROLLED SCANNING MAY
    BE REINITIATED BY ACTUATING THE CONTINUE PUSHBUTTON. WHEN A NEW SCAN
    IS INITIATED AT A POINT OF MOMENTARY ACQUISITION, AZIMUTH AND
    ELEVATION OFFSETS WILL BE ENTERED BY THE PROGRAM (OR ADDED TO
    PREVIOUS OFFSETS) IN ORDER TO CORRESPOND TO THE CHANGE OF CENTER.

(5) IF ACQUISITION IS SUSTAINED FOR MORE THAN ONE SECOND AFTER A
    MOMENTARY ACQUISITION, AUTOMATIC TRACKING MODE IS INITIATED.

(6) WHEN ACQUISITION IS LOST AFTER AUTOMATIC TRACKING MODE HAS BEEN
    INITIATED, THE PROGRAM GOES INTO RATE MEMORY. IF THE SIGNAL GOES
    ABOVE THRESHOLD DURING RATE MEMORY, AUTOMATIC TRACKING IS
    REINITIATED. IF RATE MEMORY TERMINATES AFTER APPROXIMATELY ONE
    MINUTE, SCAN PROCEDURES MUST BE REINITIATED BY THE OPERATOR. THE
    TIME FOR RATE MEMORY AND THE PROGRAM CONTROLLED SCAN PARAMETERS WILL
    BE DIFFERENT FOR RECEIVERS I AND 2.

C. SPIRAL (SCAN)

THE SPIRAL (SCAN) PUSHBUTTON SELECTS SPIRAL SCANNING IN CONJUNCTION WITH
THE DESIGNATE AZ-EL, PROGRAM (TRACK), DIGITAL SLAVE, OR DESIGNATE RA-DEC
PUSHBUTTONS IN GROUP I. THE PARAMETERS OF THE SPIRAL--THE INCREMENT,
AMPLITUDE, AND RATE--ARE ENTERED THROUGH THE SCAN PARAMETER THUMBWHEEL
SWITCHES AT STATION 5. THE SPIRAL WILL INITIALLY BE CENTERED ON THE
DESIGNATE OR PROGRAM TRACK COMMAND. THE SCAN IS A MODIFIED VERSION OF
THE SPIRAL OF ARCHIMEDES. THE SPIRAL WILL COIL AWAY FROM THE CENTER
UNTIL THE SCAN LIMITS (DETERMINED BY THE OPERATOR SELECTED SCAN
PARAMETERS) ARE REACHED AND THEN COIL BACK INTO THE CENTER AND REPEAT
THE SEQUENCE. THE DIRECTION OF ROTATION REMAINS CONSTANT.

THE INCREMENT OF THE SPIRAL IS DEFINED BY THE SCAN PARAMETER THUMBWHEEL
SWITCH AT STATION 5. THE INCREMENT IS EQUAL TO THE SEPERATION BETWEEN
THE LOOPS OF THE SPIRAL AND IS A NUMBER BETWEEN .00 AND .99 DEGREES,
WHERE .00 IS A POINT AND .99 IS THE SPIRAL WHICH OPENS FASTEST. THE
INCREMENT FOR THESE SCANS IS REFERRED TO LINEAR AZIMUTH AND ELEVATION
SCALES. IN PRACTICE, THE SCANS ARE DISTORTED AS A RESULT OF EFFECTIVE
CHANGES IN THE AZIMUTH AND ELEVATION SCALES.

THE AMPLITUDE OF THE SPIRAL IS DEFINED BY THE SCAN PARAMETER THUMBWHEEL
SWITCH AT STATION 5. THE AMPLITUDE EQUALS THE DISTANCE FROM THE CENTER
OF THE SPIRAL TO ITS MAXIMUM VALUE AND IS EQUAL TO A NUMBER BETWEEN 0.0
AND 9.9 DEGREES.

THE RATE OF THE SPIRAL SCAN IS DEFINED BY THE SCAN PARAMETER
THUMBWHEEL SWITCH AT STATION 5. THE RATE IS EQUAL TO THE FRACTION OF THE
MAXIMUM PERMITTED SCAN RATE AND IS A NUMBER BETWEEN .00 AND .99.

NEW SCAN PARAMETERS MAY BE ENTERED AT ANY TIME BY RESETTING THE
THUMBWHEEL SWITCHES AND DEPRESSING THE SPIRAL (SCAN) PUSHBUTTON.

WHENEVER NEW SCANS ARE INITIATED, THE PROGRAM TAKES THE COURSE OF LEAST
ACTION; I. E., THE NEW SCAN WILL START AT THE POSITION NEAREST TO THE
LAST POSITION OF THE PREVIOUS SCAN.

ACTUATING THE HOLD PUSHBUTTON WILL STOP AND HOLD THE SCAN AT ITS PRESENT
POSITION, WHEREAS THE CONTINUE PUSHBUTTON WILL RESTART THE SCAN FROM THAT
POSITION.

IF PROGRAM NUMBER 7XX IS BEING USED IN CONJUNCTION WITH ANY NON-CLEAR
SCAN MODE (GROUP 2), CLEARING THIS GROUP WILL RECENTER THE SCAN AROUND
THE LAST ANTENNA POSITION AND WILL AUTOMATICALLY ENTER THE AZIMUTH AND
ELEVATION OFFSETS OR ADD THEM TO ANY EXISTING OFFSETS.

IF LIMIT HOLD (PROGRAM NUMBER 6XX FOR DESIGNATE AZ-EL MODE ONLY) HAS BEEN
SELECTED AND THE ANTENNA AZIMUTH AND/OR ELEVATION LIMITS ARE NOT
CONSISTENT WITH THE SCAN PARAMETERS, THE ANTENNA WILL MOVE UNTIL THE
PROGRAM LIMITS ARE ENCOUNTERED AND THEN HOLD.

IF AZIMUTH AND/OR ELEVATION LIMITS CONFLICT WITH THE SCAN PARAMETERS,
THE PROGRAM WILL DISTORT THESE PARAMETERS TO CONFORM WITH THE LIMITS.

AUTOMATIC ACQUISITION, SPIRAL SCAN, FOR DESIGNATE AZ-EL AND
DESIGNATE RA-DEC, DEFINED BY PROGRAM NUMBERS OXX AND 1XX, PROCEEDS IN
THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS THROUGH THE THUMBWHEEL
    SWITCHES AT STATION 5. IN ADDITION, THE OPERATOR MUST ACTUATE THE
    SPIRAL (SCAN) AND ONE OF THE DESIGNATE PUSHBUTTONS. IF NO SCAN IS
    SELECTED, BEHAVIOR UPON ACQUISITION--MOMENTARY OR OTHERWISE--IS THE
    SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) UPON A MOMENTARY ACQUISITION, THE OPERATOR SPIRAL SCAN WILL
    AUTOMATICALLY JUMP INTO A PROGRAM SPIRAL SCAN CENTERED UPON THE
    ACQUISITION POINT. NO ATTEMPT IS YET MADE FOR AUTOMATIC TRACKING. IF
    ANOTHER MOMENTARY ACQUISITION IS OBTAINED WHILE IN PROGRAM CONTROLLED
    SPIRAL SCAN, A NEW SCAN IS INITIATED ABOUT THAT POINT OF MOMENTARY
    ACQUISITION. WHEN A NEW SCAN IS INITIATED AT A POINT OF MOMENTARY
    ACQUISITION, AZIMUTH AND ELEVATION OFFSETS WILL BE ENTERED BY THE
    PROGRAM (OR ADDED TO PREVIOUS OFFSETS) IN ORDER TO CORRESPOND TO THE
    NEW CENTER.

(4) IF ACQUISITION IS SUSTAINED FOR MORE THAN ONE SECOND AFTER A
    MOMENTARY ACQUISITION, AUTOMATIC TRACKING MODE IS INITIATED.

(5) IF, ON THE OTHER HAND, NO FURTHER ACQUISITION IS MADE AFTER THE
    PROGRAM DEFINED SPIRAL SCAN HAS EXPANDED TO ITS MAXIMUM AMPLITUDE,
    THE OPERATOR DEFINED SCAN WILL RESUME CENTERED ABOUT THE LAST
    ACQUISITION POINT.

(6) WHEN ACQUISITION IS LOST AFTER AUTOMATIC TRACKING MODE HAS BEEN
    INITIATED, THE PROGRAM GOES INTO RATE MEMORY. IF THE SIGNAL GOES
    ABOVE THRESHOLD DURING RATE MEMORY, AUTOMATIC TRACKING IS
    REINITIATED. IF RATE MEMORY TERMINATES AFTER APPROXIMATELY ONE
    MINUTE, SCAN PROCEDURES MUST BE REINITIATED BY THE OPERATOR. THE
    TIME FOR RATE MEMORY AND THE PROGRAM CONTROLLED SCAN PARAMETERS WILL
    BE DIFFERENT FOR RECEIVERS 1 AND 2.

UNCONDITIONAL ACQUISITION, SPIRAL SCAN, FOR DESIGNATE AZ-EL AND
DESIGNATE RA-DEC, DEFINED BY PROGRAM NUMBERS 2XX THROUGH 4XX, PROCEEDS
IN THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS THROUGH THE THUMBWHEEL
    SWITCHES AT STATION 5. IN ADDITION, THE OPERATOR MUST ACTUATE THE
    SPIRAL (SCAN) AND ONE OF THE DESIGNATE PUSHBUTTONS. IF NO SCAN IS
    SELECTED, BEHAVIOR UPON ACQUISITION--MOMENTARY OR OTHERWISE--IS THE
    SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) THE OPERATOR SELECTED SPIRAL SCAN WILL INITIALLY BE CENTERED ON
    THE DESIGNATE COMMAND.

(4) THE SPIRAL SCAN WILL PROCEED UNTIL A MOMENTARY ACQUISITION IS
    OBTAINED. UPON MOMENTARY ACQUISITION, THE PROGRAM IMMEDIATELY
    ATTEMPTS ACQUISITION. IF ACQUISITION IS NOT ACCOMPLISHED, THE SCAN
    WILL HOLD AT ITS PRESENT POSITION. OPERATOR CONTROLLED SCANNING MAY
    BE REINITIATED BY ACTUATING THE CONTINUE PUSHBUTTON. WHEN A NEW SCAN
    IS INITIATED AT A POINT OF MOMENTARY ACQUISITION, AZIMUTH AND
    ELEVATION OFFSETS WILL BE ENTERED BY THE PROGRAM (OR ADDED TO
    PREVIOUS OFFSETS) IN ORDER TO CORRESPOND TO THE CHANGE OF CENTER.

(5) IF ACQUISITION IS SUSTAINED FOR MORE THAN ONE SECOND AFTER A
    MOMENTARY ACQUISITION, AUTOMATIC TRACKING MODE IS INITIATED.

(6) WHEN ACQUISITION IS LOST AFTER AUTOMATIC TRACKING MODE HAS BEEN
    INITIATED, THE PROGRAM GOES INTO RATE MEMORY. IF THE SIGNAL GOES
    ABOVE THRESHOLD DURING RATE MEMORY, AUTOMATIC TRACKING IS
    REINITIATED. IF RATE MEMORY TERMINATES AFTER APPROXIMATELY ONE
    MINUTE, SCAN PROCEDURES MUST BE REINITIATED BY THE OPERATOR. THE
    TIME FOR RATE MEMORY AND THE PROGRAM CONTROLLED SCAN PARAMETERS WILL
    BE DIFFERENT FOR RECEIVERS 1 AND 2.

BOTH AUTOMATIC AND UNCONDITIONAL AQUISITION IN PROGRAM MODE WITH PROGRAM
RETENTION WILL CONTINUE TO PROCESS PROGRAM TRACK AFTER AUTOMATIC TRACKING
HAS BEEN ESTABLISHED.

BOTH AUTOMATIC AND UNCONDITIONAL ACQUISITION IN PROGRAM MODE WITH NO
PROGRAM RETENTION WILL STOP PROCESSING PROGRAM TRACK ONCE THE AUTOMATIC
TRACKING MODE HAS BEEN ESTABLISHED.

AUTOMATIC ACQUISITION, SPIRAL SCAN, FOR THE PROGRAM MODE, DEFINED BY
PROGRAM NUMBERS OXX AND 1XX, PROCEEDS IN THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS THROUGH THE THUMBWHEEL
    SWITCHES AT STATION 5. IN ADDITION, THE OPERATOR MUST ACTUATE THE
    SPIRAL (SCAN) AND ONE OF THE DESIGNATE PUSHBUTTONS. IF NO SCAN IS
    SELECTED, BEHAVIOR UPON ACQUISITION--MOMENTARY OR OTHERWISE--IS THE
    SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) THE OPERATOR SELECTED SPIRAL SCAN WILL INITIALLY BE CENTERED ON THE
    PROGRAM TRACK COMMAND. THEREFORE, THE CENTER OF THE SPIRAL SCAN WILL
    MOVE ALONG THE PROGRAM TRACKING PATH.

(4) UPON MOMENTARY ACQUISITION, THE OPERATOR SPIRAL SCAN WILL
    AUTOMATICALLY JUMP INTO A PROGRAM SPIRAL SCAN CENTERED UPON THE
    ACQUISITION POINT. NO ATTEMPT IS YET MADE FOR AUTOMATIC TRACKING. IF
    ANOTHER MOMENTARY ACQUISITION IS OBTAINED WHILE IN PROGRAM CONTROLLED
    SPIRAL SCAN, A NEW SCAN IS INITIATED ABOUT THAT POINT OF MOMENTARY
    ACQUISITION. WHEN A NEW SCAN IS INITIATED AT A POINT OF MOMENTARY
    ACQUISITION, AZIMUTH AND ELEVATION OFFSETS WILL BE ENTERED BY THE
    PROGRAM (OR ADDED TO PREVIOUS OFFSETS) IN ORDER TO CORRESPOND TO THE
    NEW CENTER.

(5) IF ACQUISITION IS SUSTAINED FOR MORE THAN ONE SECOND AFTER A
    MOMENTARY ACQUISITION, AUTOMATIC TRACKING MODE IS INITIATED.

(6) IF, ON THE OTHER HAND, NO FURTHER ACQUISITION IS MADE AFTER THE
    SPIRAL HAS EXPANDED TO ITS MAXIMUM AMPLITUDE, THE OPERATOR SPIRAL
    SCAN WILL RESUME CENTERED ABOUT THE LAST ACQUISITION POINT.

(7) WHEN ACQUISITION IS LOST AFTER AUTOMATIC TRACKING MODE HAS BEEN
    INITIATED, THE PROGRAM GOES INTO RATE MEMORY. IF THE SIGNAL GOES
    ABOVE THRESHOLD DURING RATE MEMORY, AUTOMATIC TRACKING IS
    REINITIATED. IF RATE MEMORY TERMINATES AFTER APPROXIMATELY ONE
    MINUTE, CONTROL IS RETURNED TO PROGRAM TRACK BUT WITH NO SCAN (OR
    OTHER SELECTIONS IF THERE IS NO PROGRAM RETENTION). ANY NEW SCAN
    MUST BE REINITIATED BY THE OPERATOR. THE TIME FOR RATE MEMORY AND
    THE PROGRAM CONTROLLED SCAN PARAMETERS WILL BE DIFFERENT FOR
    RECEIVERS 1 AND 2.

UNCONDITIONAL ACQUISITION, SPIRAL SCAN, IN PROGRAM MODE, DEFINED BY
PROGRAM NUMBERS 2XX AND 3XX, PROCEEDS IN THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS THROUGH THE THUMBWHEEL
    SWITCHES AT STATION 5. IN ADDITION, THE OPERATOR MUST ACTUATE THE
    SPIRAL (SCAN) AND ONE OF THE DESIGNATE PUSHBUTTONS. IF NO SCAN IS
    SELECTED, BEHAVIOR UPON ACQUISITION--MOMENTARY OR OTHERWISE--IS THE
    SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) THE OPERATOR SELECTED SPIRAL SCAN WILL INITIALLY BE CENTERED ON THE
    PROGRAM TRACK COMMAND. THEREFORE, THE CENTER OF THE SPIRAL SCAN WILL
    MOVE ALONG THE PROGRAM TRACKING PATH.

(4) THE SPIRAL SCAN WILL PROCEED UNTIL A MOMENTARY ACQUISITION IS
    OBTAINED. UPON MOMENTARY ACQUISITION, THE PROGRAM IMMEDIATELY
    ATTEMPTS AQUISITION. IF ACQUISITION IS NOT ACCOMPLISHED, THE SCAN
    WILL HOLD AT ITS PRESENT POSITION. OPERATOR CONTROLLED SCANNING MAY
    BE REINITIATED BY ACTUATING THE CONTINUE PUSHBUTTON; BUT THE NEW SCAN
    WILL BE CENTERED ABOUT THE LAST ACQUISITION POINT.

(5) IF ACQUISITION IS SUSTAINED FOR MORE THAN ONE SECOND AFTER A
    MOMENTARY ACQUISITION, AUTOMATIC TRACKING MODE IS INITIATED.

(6) WHEN ACQUISITION IS LOST AFTER AUTOMATIC TRACKING MODE HAS BEEN
    INITIATED, THE PROGRAM GOES INTO RATE MEMORY. IF THE SIGNAL GOES
    ABOVE THRESHOLD DURING RATE MEMORY, AUTOMATIC TRACKING IS
    REINITIATED. IF RATE MEMORY TERMINATES AFTER APPROXIMATELY ONE
    MINUTE, CONTROL IS RETURNED TO PROGRAM TRACK BUT WITH NO SCAN. ANY
    NEW SCAN MUST BE REINITIATED BY THE OPERATOR. THE TIME FOR RATE
    MEMORY AND THE PROGRAM CONTROLLED SCAN PARAMETERS WILL BE DIFFERENT
    FOR RECEIVERS 1 AND 2.

PROGRAM CORRECT CONTROL, SPIRAL SCAN, IN PROGRAM MODE, DEFINED BY PROGRAM
NUMBER 4XX, PROCEEDS IN THE FOLLOWING MANNER:

(1) EITHER ONE OR BOTH OF THE ENABLE RECEIVER PUSHBUTTON SWITCHES AT
    STATION 5 MUST BE ACTUATED.

(2) THE OPERATOR MUST DEFINE THE SCAN PARAMETERS THROUGH THE THUMBWHEEL
    SWITCHES AT STATION 5. IN ADDITION, THE OPERATOR MUST ACTUATE THE
    SPIRAL (SCAN) AND ONE OF THE DESIGNATE PUSHBUTTONS. IF NO SCAN IS
    SELECTED, BEHAVIOR UPON ACQUISITION--MOMENTARY OR OTHERWISE--IS THE
    SAME AS IF SPIRAL SCAN HAD BEEN SELECTED.

(3) THE OPERATOR SELECTED SPIRAL SCAN WILL INITIALLY BE CENTERED ON THE
    PROGRAM TRACK COMMAND. THEREFORE, THE CENTER OF THE SPIRAL SCAN WILL
    MOVE ALONG THE PROGRAM TRACKING PATH.

(4) UPON MOMENTARY ACQUISITION, THE OPERATOR SPIRAL SCAN WILL
    AUTOMATICALLY JUMP INTO A PROGRAM SPIRAL SCAN CENTERED UPON THE
    ACQUISITION POINT. THE RELATIVE SIGNAL STRENGTH AT SUCCESSIVE
    POSITIONS IN THE SCAN IS STORED BY THE PROGRAM; AND UPON COMPLETING
    THE PROGRAM CONTROLLED SCAN, PROGRAM TRACKING IS CONTINUED AT THE
    POINT OF MAXIMUM SIGNAL STRENGTH. THE OPERATOR MUST REINITIATE
    PROGRAM CORRECT CONTROL IF THE PROGRAM TRACK IS TO BE PEAKED AGAIN.

D. HOLD

THE HOLD PUSHBUTTON WILL CAUSE SCANNING TO STOP AT ITS PRESENT POSITION
AND HOLD. THE SCAN MAY BE CONTINUED BY ACTUATING THE CONTINUE PUSHBUTTON
IN THE SAME GROUP. SEE THE CONTINUE PUSHBUTTON FOR FURTHER DETAILS.

IF PROGRAM NUMBER 7XX IS BEING USED IN CONJUNCTION WITH ANY NON-CLEAR
SCAN MODE (GROUP 2), CLEARING THIS GROUP WILL RECENTER THE SCAN AROUND
THE LAST ANTENNA POSITION AND WILL AUTOMATICALLY ENTER THE AZIMUTH AND
ELEVATION OFFSETS OR ADD THEM TO ANY EXISTING OFFSETS.

E. CONTINUE

THE CONTINUE PUSHBUTTON WILL CONTINUE (WITH NO CHANGE IN SCAN PARAMETERS)
A SCAN WHICH HAS BEEN STOPPED AND IS HOLDING BECAUSE A POSITION OUTSIDE
OF PROGRAM LIMITS HAS BEEN DESIGNATED OR BECAUSE THE PROGRAM LIMITS HAVE
BEEN REACHED.

IF PROGRAM NUMBER 7XX IS BEING USED IN CONJUNCTION WITH ANY NON-CLEAR
SCAN MODE (GROUP 2), CLEARING THIS GROUP WILL RECENTER THE SCAN AROUND
THE LAST ANTENNA POSITION AND WILL AUTOMATICALLY ENTER THE AZIMUTH AND
ELEVATION OFFSETS OR ADD THEM TO ANY EXISTING OFFSETS.

GROUP 3

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.

B. ADD (TIME OFFSET)

THE ADD PUSHBUTTON IN THIS GROUP WILL OFFSET THE GMT TIME BY UP TO
PLUS 7 MINUTES 59.999 SECONDS. THE MAGNITUDE OF THE TIME OFFSET IS
DEFINED BY THE TIME PRESET THUMBWHEEL SWITCH AT STATION 5.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK
DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL IGNORE
THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE FROM GROUP 1 HAS
BEEN SELECTED.

C. SUBTRACT (TIME OFFSET)

THE SUBTRACT PUSHBUTTON IN THIS GROUP WILL OFFSET THE GMT TIME BY UP TO
MINUS 7 MINUTES 59.999 SECONDS. THE MAGNITUDE OF THIS OFFSET IS DEFINED
BY THE TIME PRESET THUMBWHEEL SWITCH AT STATION 5.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK
DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL IGNORE
THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE FROM GROUP 1 HAS
BEEN SELECTED.

GROUP 4

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.

B. ADD (AZIMUTH OFFSET)

THE ADD PUSHBUTTON IN THIS GROUP WILL OFFSET THE AZIMUTH BY UP TO
PLUS 99.999 DEGREES. THE MAGNITUDE OF THE AZIMUTH OFFSET IS DEFINED BY
THE OFFSET PORTION OF THE AZIMUTH DESIGNATE THUMBWHEEL SWITCH AT
STATION 5.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK
DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL IGNORE
THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP I HAS BEEN SELECTED.

C. SUBTRACT (AZIMUTH OFFSET)

THE SUBTRACT PUSHBUTTON IN THIS GROUP WILL OFFSET THE AZIMUTH BY UP TO
MINUS 99.999 DEGREES. THE MAGNITUDE OF THE AZIMUTH OFFSET IS DEFINED
BY THE OFFSET PORTION OF THE AZIMUTH DESIGNATE THUMBWHEEL SWITCH AT
STATION 5.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK
DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL IGNORE
THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP I HAS BEEN SELECTED.

GROUP 5

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.

B. ADD (ELEVATION OFFSET)

THE ADD PUSHBUTTON IN THIS GROUP WILL OFFSET THE ELEVATION BY UP TO
PLUS 99.999 DEGREES. THE MAGNITUDE OF THE ELEVATION OFFSET IS DEFINED BY
THE OFFSET PORTION OF THE ELEVATION DESIGNATE THUMBWHEEL SWITCH AT
STATION 5.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK
DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL IGNORE
THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP 1 HAS BEEN SELECTED.

C. SUBTRACT (ELEVATION OFFSET)

THE SUBTRACT PUSHBUTTON IN THIS GROUP WILL OFFSET THE ELEVATION BY UP TO
MINUS 99.999 DEGREES. THE MAGNITUDE OF THE ELEVATION OFFSET IS DEFINED
BY THE OFFSET PORTION OF THE ELEVATION DESIGNATE THUMBWHEEL SWITCH AT
STATION 5.

IF AN AZIMUTH, ELEVATION AND/OR TIME OFFSET IS BEING USED IN CONJUNCTION
WITH PROGRAM TRACK WHEN A PROGRAM LIMIT FOR ANTENNA POSITION IS REACHED,
A FLASHBACK ON ALL OF THE SELECTED PUSHBUTTONS WILL BE RETURNED EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

IF AN AZIMUTH OR ELEVATION OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK
DESIGNATES A POSITION OUTSIDE OF PROGRAM LIMITS, THE PROGRAM WILL IGNORE
THAT OFFSET AND RETURN A FLASHBACK TO THAT OFFSET PUSHBUTTON ONLY.

IF A TIME OFFSET USED IN CONJUNCTION WITH PROGRAM TRACK DESIGNATES A
POSITION OUTSIDE OF PROGRAM LIMITS, THE ANTENNA WILL HOLD; AND A
FLASHBACK WILL BE RETURNED TO ALL OF THE SELECTED PUSHBUTTONS EXCEPT
THOSE IN GROUPS 6 AND 7 WHICH WILL BE CLEARED.

GROUP 6

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP AS
WELL AS IN GROUP 7.

B. EARTH RADII-CPS/GC

THE EARTH RADII-CPS/GC PUSHBUTTON WILL DISPLAY THE RANGE AND RANGE RATE
(IN EARTH RADII AND CPS/GC, RESPECTIVELY) FROM THE LOCAL SITE AND, UNDER
CERTAIN CIRCUMSTANCES, FROM A REMOTE SITE TO A SATELLITE OR CELESTIAL
OBJECT. THE COMPUTATIONS APPEAR ONCE PER SECOND THROUGH THE LOCAL AND
REMOTE IN-LINE DISPLAYS AT STATIONS 4 AND 5.

THE REMOTE RANGE AND RANGE RATE MAY BE DISPLAYED BY FIRST DEFINING A
REMOTE SITE AND THEN BY SELECTING THAT SITE THROUGH THE APPROPRIATE
PUSHBUTTON SWITCH IN GROUP 7. REMOTE SITES MAY NEVER BE USED EXCEPT
IN CONJUNCTION WITH THE LOCAL SITE. IF A REMOTE SITE HAS BEEN DEFINED
AND SELECTED, THE ADD LOCAL PUSHBUTTON WILL ENTER THE REMOTE DISPLAYS
WITH THE RANGE AND RANGE RATE FOR THE TOTAL PATH BETWEEN THE LOCAL SITE,
THE SATELLITE OR CELESTIAL OBJECT, AND THE REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE FROM GROUP I HAS
BEEN SELECTED.

C. FREQ. I

THE FREQ. I PUSHBUTTON WILL DISPLAY THE DOPPLER SHIFT AND FREE SPACE
ATTENNUATION BETWEEN ISOTROPIC ANTENNAS (IN CPS AND DECIBELS,
RESPECTIVELY) FROM THE LOCAL SITE AND, UNDER CERTAIN CIRCUMSTANCES, FROM
A REMOTE SITE TO A SATELLITE OR CELESTIAL OBJECT. THE COMPUTATIONS
APPEAR ONCE PER SECOND THROUGH THE LOCAL AND REMOTE IN-LINE DISPLAYS
AT STATIONS 4 AND 5.

THE REMOTE DOPPLER SHIFT AND FREE SPACE ATTENNUATION MAY BE DISPLAYED
BY FIRST DEFINING A REMOTE SITE AND THEN BY SELECTING THAT SITE THROUGH
THE APPROPRIATE PUSHBUTTON IN GROUP 7. REMOTE SITES MAY NEVER BE USED
EXCEPT IN CONJUNCTION WITH THE LOCAL SITE. IF A REMOTE SITE HAS BEEN
DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON WILL ENTER THE REMOTE
DISPLAYS WITH THE FREE SPACE ATTENNUATION AND DOPPLER SHIFT FOR THE
TOTAL PATH BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT,
AND THE REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE FROM GROUP I HAS
BEEN SELECTED.

D. FREQ. 2

THE FREQ. 2 PUSHBUTTON WILL DISPLAY THE DOPPLER SHIFT AND FREE SPACE
ATTENNUATION BETWEEN ISOTROPIC ANTENNAS (IN CPS AND DECIBELS,
RESPECTIVELY) FROM THE LOCAL SITE AND, UNDER CERTAIN CIRCUMSTANCES, FROM
A REMOTE SITE TO A SATELLITE OR CELESTIAL OBJECT. THE COMPUTATIONS
APPEAR ONCE PER SECOND THROUGH THE LOCAL AND REMOTE IN-LINE DISPLAYS
AT STATIONS 4 AND 5.

THE REMOTE DOPPLER SHIFT AND FREE SPACE ATTENNUATION MAY BE DISPLAYED
BY FIRST DEFINING A REMOTE SITE AND THEN BY SELECTING THAT SITE THROUGH
THE APPROPRIATE PUSHBUTTON IN GROUP 7. REMOTE SITES MAY NEVER BE USED
EXCEPT IN CONJUNCTION WITH THE LOCAL SITE. IF A REMOTE SITE HAS BEEN
DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON WILL ENTER THE REMOTE
DISPLAYS WITH THE FREE SPACE ATTENNUATION AND DOPPLER SHIFT FOR THE
TOTAL PATH BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT,
AND THE REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE FROM GROUP I HAS
BEEN SELECTED.

E. FREQ. 3

THE FREQ. 3 PUSHBUTTON WILL DISPLAY THE DOPPLER SHIFT AND FREE SPACE
ATTENNUATION BETWEEN ISOTROPIC ANTENNAS (IN CPS AND DECIBELS,
RESPECTIVELY) FROM THE LOCAL SITE AND, UNDER CERTAIN CIRCUMSTANCES, FROM
A REMOTE SITE TO A SATELLITE OR CELESTIAL OBJECT. THE COMPUTATIONS
APPEAR ONCE PER SECOND THROUGH THE LOCAL AND REMOTE IN-LINE DISPLAYS
AT STATIONS 4 AND 5.

THE REMOTE DOPPLER SHIFT AND FREE SPACE ATTENUATION MAY BE DISPLAYED
BY FIRST DEFINING A REMOTE SITE AND THEN BY SELECTING THAT SITE THROUGH
THE APPROPRIATE PUSHBUTTON IN GROUP 7.   REMOTE SITES MAY NEVER BE USED
EXCEPT IN CONJUNCTION WITH THE LOCAL SITE.   IF A REMOTE SITE HAS BEEN
DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON WILL ENTER THE REMOTE
DISPLAYS WITH THE FREE SPACE ATTENUATION AND DOPPLER SHIFT FOR THE
TOTAL PATH BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT,
AND THE REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE FROM GROUP I HAS
BEEN SELECTED.

GROUP 7

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.

B. REMOTE A

THE REMOTE A PUSHBUTTON WILL DISPLAY THE COMPUTATIONS FOR REMOTE SITE A
(DEFINED BY THE ROUTINE SITE.) AS SELECTED BY THE EARTH RADII-CPS/GC,
FREQ. I, FREQ. 2, OR FREQ. 3 PUSHBUTTON FROM GROUP 6.   THE COMPUTATIONS
APPEAR ONCE PER SECOND THROUGH THE REMOTE IN-LINE DISPLAYS AT STATIONS 4
AND 5.   REMOTE SITES MAY NEVER BE USED EXCEPT IN CONJUNCTION WITH THE
LOCAL SITE.

IF A REMOTE SITE HAS BEEN DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON
WILL ENTER THE REMOTE DISPLAYS WITH COMPUTATIONS FOR THE TOTAL PATH
BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT, AND THE
REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP I HAS BEEN SELECTED.

C. REMOTE B

THE REMOTE B PUSHBUTTON WILL DISPLAY THE COMPUTATIONS FOR REMOTE SITE B
(DEFINED BY THE ROUTINE SITE.) AS SELECTED BY THE EARTH RADII-CPS/GC,
FREQ. I, FREQ. 2, OR FREQ. 3 PUSHBUTTON FROM GROUP 6.   THE COMPUTATIONS
APPEAR ONCE PER SECOND THROUGH THE REMOTE IN-LINE DISPLAYS AT STATIONS 4
AND 5.   REMOTE SITES MAY NEVER BE USED EXCEPT IN CONJUNCTION WITH THE
LOCAL SITE.

IF A REMOTE SITE HAS BEEN DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON
WILL ENTER THE REMOTE DISPLAYS WITH COMPUTATIONS FOR THE TOTAL PATH
BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT, AND THE
REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP I HAS BEEN SELECTED.

D. REMOTE C

THE REMOTE C PUSHBUTTON WILL DISPLAY THE COMPUTATIONS FOR REMOTE SITE C
(DEFINED BY THE ROUTINE SITE.) AS SELECTED BY THE EARTH RADII-CPS/GC,
FREQ. I, FREQ. 2, OR FREQ. 3 PUSHBUTTON FROM GROUP 6.   THE COMPUTATIONS
APPEAR ONCE PER SECOND THROUGH THE REMOTE IN-LINE DISPLAYS AT STATIONS 4
AND 5.   REMOTE SITES MAY NEVER BE USED EXCEPT IN CONJUNCTION WITH THE
LOCAL SITE.

IF A REMOTE SITE HAS BEEN DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON
WILL ENTER THE REMOTE DISPLAYS WITH COMPUTATIONS FOR THE TOTAL PATH
BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT, AND THE
REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP I HAS BEEN SELECTED.

E. ADD LOCAL

IF A REMOTE SITE HAS BEEN DEFINED AND SELECTED, THE ADD LOCAL PUSHBUTTON
WILL ENTER THE REMOTE DISPLAYS WITH COMPUTATIONS FOR THE TOTAL PATH
BETWEEN THE LOCAL SITE, THE SATELLITE OR CELESTIAL OBJECT, AND THE
REMOTE SITE.

THIS PUSHBUTTON WILL BE CLEARED UNLESS PROGRAM MODE OR DIGITAL SLAVE MODE
FROM GROUP I HAS BEEN SELECTED.

GROUP 8

A. CLEAR

THE CLEAR PUSHBUTTON WILL CLEAR ANY SELECTION MADE WITHIN THIS GROUP.

B. SET

THE SET PUSHBUTTON AT STATION 4 WILL INITIATE AZIMUTH AND ELEVATION
DISPLAYS FOR A SATELLITE OR CELESTIAL OBJECT DEFINED BY THE ROUTINE
TRACK AT THE GMT STARTING TIME SPECIFIED BY THE REVERSE CLOCK THUMBWHEEL
SWITCH AT STATION 4. THE SET PUSHBUTTON BY ITSELF WILL PROVIDE ONLY
ONE COMPUTATION POINT. IN ADDITION, THE STARTING DATE WILL ALWAYS BE
FOR THE PRESENT DAY.

A TIME INCREMENT (OR DECREMENT) MAY BE ENTERED THROUGH THE REVERSE CLOCK
THUMBWHEEL SWITCH AT STATION 4 AFTER THE SET PUSHBUTTON HAS BEEN
ACTUATED. THE AZIMUTH AND ELEVATION DISPLAYS WILL BE INCREMENTED OR
DECREMENTED ONCE EVERY SECOND BY THE TIME ENTERED ON THE REVERSE CLOCK
THUMBWHEEL SWITCH, DEPENDING ON WHETHER THE INCREASE OR THE DECREASE
PUSHBUTTON HAS BEEN ACTIVATED.

A SINGLE INCREMENTED POINT MAY BE DISPLAYED BY MOMENTARILY ACTUATING
THE INCREASE OR DECREASE PUSHBUTTON WHILE THE HOLD PUSHBUTTON IS
DEPRESSED.

THE STARTING TIME AND THE TIME INCREMENT (OR DECREMENT) MAY BE CHANGED
AT ANY TIME DURING QUICK LOOK BY ENTERING THE NEW TIME ON THE REVERSE
CLOCK THUMBWHEEL SWITCH AND THEN ACTUATING THE APPROPRIATE PUSHBUTTON IN
GROUP 8.

THIS PUSHBUTTON WILL FUNCTION ONLY IN CONJUNCTION WITH GROUPS 6 AND 7.
SELECTING GROUPS I THROUGH 5 WILL CAUSE GROUP 8 TO CLEAR.

C. HOLD

THE HOLD PUSHBUTTON WILL CAUSE QUICK LOOK TO HOLD AT ITS PRESENT
COMPUTATION POINT. AZIMUTH AND ELEVATION COMPUTATIONS MAY BE CONTINUED
AT ANY TIME BY ACTUATING EITHER THE INCREASE OR DECREASE PUSHBUTTONS IN
THE SAME GROUP.

A SINGLE INCREMENTED POINT MAY BE DISPLAYED BY MOMENTARILY ACTUATING
THE INCREASE OR DECREASE PUSHBUTTON WHILE THE HOLD PUSHBUTTON IS
DEPRESSED.

THIS PUSHBUTTON WILL FUNCTION ONLY IN CONJUNCTION WITH GROUPS 6 AND 7.
SELECTING GROUPS 1 THROUGH 5 WILL CAUSE GROUP 8 TO CLEAR.

D. INCREASE

THE INCREASE PUSHBUTTON WILL INCREMENT THE GMT STARTING TIME ONCE EVERY
SECOND BY THE TIME SPECIFIED ON THE REVERSE CLOCK THUMBWHEEL SWITCH AT
STATION 4. THE AZIMUTH AND ELEVATION OF THE SATELLITE OR CELESTIAL
OBJECT AT THE INCREMENTED TIME WILL APPEAR ON THE IN-LINE DISPLAYS AT
STATIONS 3, 4, AND 5.

A SINGLE INCREMENTED POINT MAY BE DISPLAYED BY MOMENTARILY ACTUATING
THE INCREASE PUSHBUTTON WHILE THE HOLD PUSHBUTTON IS DEPRESSED.

THE STARTING TIME AND THE TIME INCREMENT (OR DECREMENT) MAY BE CHANGED
AT ANY TIME DURING QUICK LOOK BY ENTERING THE NEW TIME ON THE REVERSE
CLOCK THUMBWHEEL SWITCH AND THEN ACTUATING THE APPROPRIATE PUSHBUTTON IN
GROUP 8.

THIS PUSHBUTTON WILL FUNCTION ONLY IN CONJUNCTION WITH GROUPS 6 AND 7.
SELECTING GROUPS 1 THROUGH 5 WILL CAUSE GROUP 8 TO CLEAR.

E. DECREASE

THE DECREASE PUSHBUTTON WILL DECREMENT THE GMT STARTING TIME ONCE EVERY
SECOND BY THE TIME SPECIFIED ON THE REVERSE CLOCK THUMBWHEEL SWITCH AT
STATION 4. THE AZIMUTH AND ELEVATION OF THE SATELLITE OR CELESTIAL
OBJECT AT THE DECREMENTED TIME WILL APPEAR ON THE IN-LINE DISPLAYS AT
STATIONS 3, 4, AND 5.

A SINGLE DECREMENTED POINT MAY BE DISPLAYED BY MOMENTARILY ACTUATING
THE DECREASE PUSHBUTTON WHILE THE HOLD PUSHBUTTON IS DEPRESSED.

THE STARTING TIME AND THE TIME DECREMENT (OR INCREMENT) MAY BE CHANGED
AT ANY TIME DURING QUICK LOOK BY ENTERING THE NEW TIME ON THE REVERSE
CLOCK THUMBWHEEL SWITCH AND THEN ACTUATING THE APPROPRIATE PUSHBUTTON IN
GROUP 8.

THIS PUSHBUTTON WILL FUNCTION ONLY IN CONJUNCTION WITH GROUPS 6 AND 7.
SELECTING GROUPS 1 THROUGH 5 WILL CAUSE GROUP 8 TO CLEAR.

MISCELLANEOUS PUSHBUTTONS

A. ENABLE RECVR. 1

THE ENABLE RECVR. 1 PUSHBUTTON SWITCH AT STATION 5 WILL ACTIVATE
RECEIVER NUMBER 1. RECEIVER NO. 1 IS A UHF RECEIVER, NOMINALLY IN THE
RANGE OF 2 GHZ.

B. ENABLE RECVR. 2

THE ENABLE RECVR. 2 PUSHBUTTON SWITCH AT STATION 5 WILL ACTIVATE
RECEIVER NUMBER 2. RECEIVER NO. 2 IS A SHF RECEIVER, NOMINALLY IN THE
RANGE OF 8 GHZ.

C. RECEIVER EXT. SELECT

THE RECEIVER EXT. SELECT PUSHBUTTON SWITCH AT STATION 5 WILL ENABLE THE
OPERATOR TO MANUALLY SELECT RECEIVER 1 OR 2 THROUGH THE ENABLE RECEIVER
PUSHBUTTONS AT STATION 5 OR THROUGH THE APPROPRIATE CODES.

D. DEFEAT RECVR. 1

THE DEFEAT RECVR. 1 PUSHBUTTON SWITCH AT STATION 5 WILL DISABLE RECEIVER
NO. 1. RECEIVER NO. 1 IS A UHF RECEIVER, NOMINALLY IN THE RANGE OF 2 GHZ.

E. DEFEAT RECVR. 2

THE DEFEAT RECVR. 2 PUSHBUTTON SWITCH AT STATION 5 WILL DISABLE RECEIVER
NO. 2. RECEIVER NO. 2 IS A SHF RECEIVER, NOMINALLY IN THE RANGE OF 8 GHZ.

F. RECEIVER PROG. SELECT

THE RECEIVER PROG. SELECT PUSHBUTTON SWITCH AT STATION 5 WILL PROGRAM
SELECT RECEIVER 1 OR 2.

G. ACKNOWLEDGE

THE ACKNOWLEDGE PUSHBUTTON SWITCH AT STATION 5 WILL FLASH WHEN THE
OPERATOR'S ATTENTION IS DESIRED BY THE PROGRAM. IF THE OPERATOR RESPONDS
TO THE ACKNOWLEDGE PUSHBUTTON BY DEPRESSING IT, IT WILL STOP FLASHING.

H. ENTER PROGRAM NUMBER

UPON ACTUATION OF THE ENTER PROGRAM NUMBER PUSHBUTTON SWITCH AT
STATION 5, THE PROGRAM NUMBER SELECTED THROUGH THE PROGRAM THUMBWHEEL
SWITCH AT STATION 5 WILL BE ENTERED INTO THE SOFTWARE PROGRAM. THE
PROGRAM NUMBER WILL APPEAR THROUGH THE MODE IN-LINE DISPLAY AT
STATIONS 3, 4, AND 5.

EACH OF THE THREE OCTAL DIGITS IN THE PROGRAM NUMBER HAS A SPECIAL
INTERPRETATION. FOR THE MOST SIGNIFICANT DIGIT THE INTERPRETATIONS ARE

        0   AUTO-ACQUISITION, NO PROGRAM RETENTION
        1   AUTO-ACQUISITION, PROGRAM RETENTION
        2   UNCONDITIONAL ACQUISITION, NO PROGRAM RETENTION
        3   UNCONDITIONAL ACQUISITION, PROGRAM RETENTION
        4   PROGRAM CORRECT CONTROL
        5   WIDE LIMITS, DESIGNATE AZ-EL MODE ONLY
        6   HORIZON HOLD
        7   SCAN OFFSET CONTROL

    FOR THE SECOND OCTAL DIGIT THESE INTERPRETATIONS ARE

        0   DECIMAL ANTENNA AZ-EL POSITION
        1   DECIMAL ANTENNA AZ-EL VELOCITY
        2   OCTAL ANTENNA AZ-EL POSITION
        3   DECIMAL AZ-EL ERROR
        4   OCTAL COMMAND AZ-EL POSITION
        5   DECIMAL COMMAND AZ-EL POSITION WITH NO SCANS, NO CORRECTIONS,
            AND NO POSITION OR VELOCITY LIMITING
        6   DECIMAL COMMAND AZ-EL VELOCITY
        7   DECIMAL COMMAND AZ-EL POSITION

FOR THE LEAST SIGNIFICANT DIGIT THESE ARE

0   AZIMUTH, REFRACTION, AND ELEVATION CAMS
1   NO CAMS
2   REFRACTION CAM
3   AZIMUTH CAM
4   ELEVATION CAM
5   AZIMUTH AND REFRACTION CAMS
6   ELEVATION AND REFRACTION CAMS
7   AZIMUTH AND ELEVATION CAMS

SHUT-DOWN PROCEDURES

A. STOP ANY PROGRAMS WHICH MAY BE IN CURRENT USE BY FIRST DEPRESSING THE
START-STEP LEVER SWITCH ON THE COMPUTER CONSOLE TO THE STEP POSITION.

B. MASTER CLEAR THE COMPUTER BY PUSHING THE MASTER CLEAR LEVER UP AND
THEN DOWN. THIS ORDER SHOULD BE MAINTAINED IN ORDER TO AVOID ANY
POSSIBLE DIFFICULTIES.

C. TURN OFF THE MAGNETIC TAPE UNITS AS FOLLOWS:

(1) DEPRESS THE CLEAR PUSHBUTTON ON THE TAPE UNIT.
(2) PRESS THE UNLOAD PUSHBUTTON ON THE TAPE UNIT. THE TAPE HEAD
    WILL RETRACT, AND THE TAPE WILL REWIND ONTO THE RIGHT HAND REEL.
(3) DEPRESS THE POWER SWITCH ON THE TAPE UNIT. THIS WILL SHUT OFF
    THE UNIT.
(4) SLIDE THE GLASS FRONT DOOR DOWN TO ITS LOWEST POSITION.
(5) TURN THE FLUTED PLASTIC KNOB ON THE RIGHT REEL HUB COUNTER-
    CLOCKWISE TWO OR THREE TURNS AND REMOVE THE REEL. FASTEN THE
    LOOSE END OF THE TAPE WITH THE SPECIAL PEICE OF BLUE BINDING
    FOUND IN THE TAPE CANISTER.
(6) PLACE THE TAPE IN THE CANISTER AND LOCK IT. BE SURE THAT THE
    PROPER CANISTER HAS BEEN USED, AND THEN PLACE IT IN THE TAPE
    STORAGE BINS.
(7) RAISE THE GLASS FRONT DOOR.
(8) REPEAT STEPS (1) THROUGH (7) FOR THE REMAINING TAPE UNITS.

D. TURN OFF THE CARD READER WITH THE MOTOR POWER PUSHBUTTON.

E. TURN OFF THE LINE PRINTER MAINTAINING THE FOLLOWING SEQUENCE:

(1) MASTER CLEAR THE PRINTER.
(2) TURN OFF THE PRINTER (MOTOR). KEEP THIS PUSHBUTTON DEPRESSED
    FOR SEVERAL SECONDS TO ALLOW THE PRINTER DRUM TO SLOW DOWN.
(3) TURN OFF THE PRINTER LOGIC.

F. TURN OFF THE INTERFACE EQUIPMENT BY THROWING THE COMPUTER-BYPASS
SWITCH ON THE WALL BESIDE THE LINE PRINTER TO THE OFF POSITION.

G. TURN OFF THE COMPUTER POWER WITH THE RED SWITCH LOCATED ON THE
COMPUTER CONSOLE.

DIAGNOSTICS AND ERROR CODES

DIAGNOSTICS AND ERROR MESSAGES ARE PROVIDED BY NACSYS FOR MOST OPERATOR
OR PERIPHERAL EQUIPMENT INCONGRUITIES. EXPLANATIONS FOR THE DIAGNOSTICS
ARE AS FOLLOWS:

(1) ERROR CODE: XXXX

THE ERROR CODE MESSAGE SIGNIFIES AN ERROR IN THE INPUT INFORMATION.
FOLLOWING THE ERROR CODE MESSAGE IS A FOUR DIGIT CODED NUMBER
CONTAINING INFORMATION ON THE TYPE OF ERROR AND, IN THE CASE OF

INPUT CARDS OR CARD IMAGES, ITS LOCATION ON THE CARD.

THE 1000 SERIES ERROR CODES ARE ASSOCIATED WITH THE BASIC SYSTEM
LOADER AND INDICATE ERRORS IN BINARY CARDS, RELOCATABLE ROUTINES,
AND OTHER LOADING ERRORS.
THE 2000 SERIES CODES ARE ASSOCIATED WITH NACSYS SYSTEM ERRORS NOT
COVERED BY THE OTHER ERROR CODE SERIES.
THE 3000 SERIES CODES ARE ASSOCIATED WITH THE MANAGE PROGRAM, THE
NACSYS SYSTEM BUILDER.
THE 4000 SERIES CODES ARE ASSOCIATED WITH ERRORS IN THE ORBIT CARDS
OR ORBIT CARD IMAGES.
THE 5000 SERIES CODES ARE ASSOCIATED WITH ERRORS IN THE PLANET CARDS
OR PLANET CARD IMAGES (INCLUDING PLANET, SUN, OR MOON CARDS).
THE 6000 SERIES CODES ARE ASSOCIATED WITH ERRORS IN THE SITE CARDS
OR SITE CARD IMAGES.

THE ERROR CODES ARE AS FOLLOWS:

1000   LOADER ERROR, NOT A CARD IMAGE
1001   LOADER ERROR, LOCATIONS 0-15B NOT AVAILABLE FOR INPUT
1002   LOADER ERROR, FIRST CARD OF FILE MUST BE IDENTIFICATION CARD
1003   LOADER ERROR, EXCEEDS AVAILABLE MEMORY BOUNDS
1004   LOADER ERROR, IDENTIFICATION CARD OUT OF ORDER
1005   LOADER ERROR, EXIT/ENTRY CARD ILLEGAL

2000   NACSYS ERROR, END OF DIRECTORY, NO SUCH NAME
2001   NACSYS ERROR, INCORRECT ADDRESS OR ILLEGAL AREA
2002   NACSYS ERROR, NO EXECUTION ADDRESS
2003   NACSYS ERROR, COLUMNS 23-24 INCORRECT
2004   NACSYS ERROR, NOT A LINE IMAGE
2005   NACSYS ERROR, NUMBER PREFIX TO NAME INVALID

3000   MANAGE ERROR, INCORRECT NUMBER FIELD
3001   MANAGE ERROR, INCORRECT ORDER OF PATCH CARDS
3002   MANAGE ERROR, INCORRECT INPUT SPECIFICATION
3003   MANAGE ERROR, RECORD TOO LONG TO COPY IN FULL

4100   ORBT CARD 1, ERROR IN CHECK SUM

4200   ORBT CARD 2, ERROR IN CHECK SUM
4201   ORBT CARD 2, ERROR IN EPOCH
4202   ORBT CARD 2, ERROR IN MEAN ANAMOLY
4203   ORBT CARD 2, ERROR IN RIGHT ASCENSION ASCENDING NODE
4204   ORBT CARD 2, ERROR IN ARGUMENT OF PERIGEE
4205   ORBT CARD 2, ERROR IN ECCENTRICITY
4206   ORBT CARD 2, ERROR IN INCLINATION

4300   ORBT CARD 3, ERROR IN CHECK SUM
4301   ORBT CARD 3, ERROR IN MEAN MOTION
4302   ORBT CARD 3, ERROR IN FIRST TIME DERIV. OF MEAN MOTION
4303   ORBT CARD 3, ERROR IN FIRST TIME DERIV. OF R.A. ASCENDING NODE
4304   ORBT CARD 3, ERROR IN FIRST TIME DERIV. OF ARGUMENT OF PERIGEE
4305   ORBT CARD 3, ERROR IN FIRST TIME DERIV. OF ECCENTRICITY
4306   ORBT CARD 3, ERROR IN FIRST TIME DERIV. OF INCLINATION

4400   ORBT CARD 4, ERROR IN CHECK SUM
4401   ORBT CARD 4, ERROR IN SECOND TIME DERIV. OF MEAN MOTION
4402   ORBT CARD 4, ERROR IN THIRD TIME DERIV. OF MEAN MOTION
4403   ORBT CARD 4, ERROR IN SECOND TIME DERIV. R.A. ASCENDING NODE
4404   ORBT CARD 4, ERROR IN SECOND TIME DERIV. ARGUMENT OF PERIGEE
4405   ORBT CARD 4, ERROR IN SECOND TIME DERIV. OF ECCENTRICITY

4500   ORBT CARD 5, ERROR IN CHECK SUM
4501   ORBT CARD 5, ERROR IN SEMI-MAJOR AXIS
4502   ORBT CARD 5, ERROR IN FIRST TIME DERIV. OF SEMI-MAJOR AXIS
4503   ORBT CARD 5, ERROR IN SECOND TIME DERIV. OF SEMI-MAJOR-AXIS

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5100   MOON CARD, NO CHECK SUM
5101   MOON CARD, ERROR IN RIGHT ASCENSION
5102   MOON CARD, ERROR IN DECLINATION
5103   MOON CARD, ERROR IN HORIZONTAL PARALLAX

5200   PLNT OR SOLR CARD, NO CHECK SUM
5201   PLNT OR SOLR CARD, ERROR IN RIGHT ASCENSION
5202   PLNT OR SOLR CARD, ERROR IN DECLINATION
5203   PLNT OR SOLR CARD, ERROR IN TRUE DISTANCE

5300   STAR CARD, NO CHECK SUM
5301   STAR CARD, ERROR IN CATALOG NUMBER
5302   STAR CARD, ERROR IN YEAR
5303   STAR CARD, ERROR IN COLUMN 30 (MUST BE AN O OR AN R)
5304   STAR CARD, ERROR IN RIGHT ASCENSION
5305   STAR CARD, ERROR IN DECLINATION
5306   STAR CARD, ERROR IN R. A. COMPONENT OF PROPER MOTION
5307   STAR CARD, ERROR IN DECLINATION COMPONENT OF PROPER MOTION

6000   SITE CARD, ERROR IN CHECK SUM
6002   SITE CARD, ERROR IN HEIGHT ABOVE MEAN SEA LEVEL
6003   SITE CARD, ERROR IN LATITUDE
6004   SITE CARD, ERROR IN LONGITUDE
```

(2) ILLEGAL

ILLEGAL IS AN ERROR MESSAGE SIGNIFYING AN INCORRECT RESPONSE ON THE
PART OF THE OPERATOR. INCORRECT RESPONSES INCLUDE BOTH ILLEGAL
CHARACTERS AND ILLEGAL WORDS.

(3) UNDEFINED

AN UNDEFINED DIAGNOSTIC RESULTS WHEN A DATA SOURCE WHICH HAS NOT
BEEN PREVIOUSLY DEFINED IS CALLED UPON BY THE PROGRAM.

(4) IN AUTO-TRACK MODE

THE DIAGNOSTIC, IN AUTO-TRACK MODE, OCCURS WHEN THE PROGRAM IS IN
AUTOMATIC TRACKING MODE AND A REQUEST FOR TRACK IS MADE BEFORE
THE AUTOMATIC TRACKING MODE HAS BEEN REMOVED.

(5) OBJECT SELECTED BY TRACK, ANOTHER CHOICE?

THIS DIAGNOSTIC OCCURS IF A DATA SOURCE OTHER THAN SITE IS BEING
PROCESSED BY TRACK WHEN IT IS REQUESTED BY SOME OTHER ROUTINE.
UPON RETURNING THIS MESSAGE, CONTROL WILL AGAIN BE TRANSFERRED TO
THE REQUEST FOR DESTINATION.

(6) A (ALSO B OR C) IS BEING PROCESSED, USE ANOTHER LOCATION

THIS DIAGNOSTIC OCCURS IF A SITE IS BEING PROCESSED BY TRACK WHEN
IT IS REQUESTED BY SOME OTHER ROUTINE. UPON RETURNING THIS MESSAGE,
CONTROL WILL AGAIN BE TRANSFERRED TO THE REQUEST FOR DESTINATION.

(7) IMPRACTICAL DATA

THIS DIAGNOSTIC OCCURS IN THE ROUTINE REFR. AN IMPRACTICAL DATA
MESSAGE IS RETURNED IF THE TEMPERATURE, PRESSURE, RELATIVE HUMIDITY,
OR N(S) IS OUTSIDE THE PERMITTED LIMITS. AN IMPRACTICAL

TEMPERATURE, PRESSURE, OR RELATIVE HUMIDITY WILL RETURN COMMAND TO
THOSE PARAMETERS, RESPECTIVELY; BUT AN IMPRACTICAL N(S) WILL RETURN
CONTROL TO METHOD (A, B, C).

(8) CARD READER DIAGNOSTICS

THESE DIAGNOSTICS ARE SELF EXPLANATORY AND INCLUDE THE FOLLOWING:

HOPPER EMPTY, RELOAD READY?   (Y OR EXIT):
FEED FAILURE, RESTACK READY?   (Y OR EXIT):
PROGRAM ERROR, RELOAD CARD READY?   (Y OR EXIT):
AMP. FAILURE, RELOAD CARD READY?   (Y OR EXIT):
CARD READER OFF, WAITING
STACKER FULL, WAITING

(9) LINE PRINTER DIAGNOSTICS

THESE DIAGNOSTICS ARE SELF EXPLANATORY AND INCLUDE THE FOLLOWING:

PRINTER OFFLINE, READY?   (Y OR EXIT)
PRINTER OUT OF PAPER, READY?   (Y OR EXIT)
PRINTER DRUM STATIONARY, READY?   (Y OR EXIT)

(10) **END OF FILE**

THIS DIAGNOSTIC OCCURS WHEN A DATA SOURCE IS REQUESTED WHICH IS NOT
ON TAPE. THE ROUTINE WILL SEARCH THE TAPE UNTIL IT COMES TO THE
DATA SOURCE REQUESTED. IF THE DATA SOURCE IS NOT ON TAPE, THE
ROUTINE WILL SEARCH UNTIL IT ENCOUNTERS A DOUBLE END OF FILE MARK
INDICATING THE END THE INFORMATION ON THAT TAPE.

(11) FIELD TOO LARGE

NO NUMBER GREATER THAN TWENTY CHARACTERS (INCLUDING SIGNS, DECIMAL
POINT, DIGITS, AND CHARACTER FOR SEPARATING THE E-FIELD) WILL BE
ACCEPTED.

(12) E FIELD TOO LARGE

THE E-FIELD (INITIATED BY TYPING E OR EX) CANNOT BE LONGER THAN
THREE DECIMAL DIGITS.

(13) INSUFFICIENT DATA

THIS DIAGNOSTIC OCCURS WHEN INSUFFICIENT DATA IS AVAILABLE FOR
A DATA SOURCE OVER THE TIME PERIOD REQUESTED BY THE OPERATOR.

(14) **END OF DAY FILE**

THIS DIAGNOSTIC RESULTS WHEN INSUFFICIENT DATA IS AVAILABLE FOR
A DATA SOURCE OVER THE TIME PERIOD REQUESTED BY THE OPERATOR.

(15) **DATE FILE BAD**

THIS DIAGNOSTIC INDICATES A PARITY ERROR OR A RECORD OF ILLEGAL
LENGTH.

(16) OBJECT SELECTED BY TRACK, USE ANOTHER LOCATION

SEE EXPLANATION FOR DIAGNOSTIC (5).

CONCLUSION

In designing the digital control system for the Waldorf antenna, operator-oriented software programming was emphasized wherever possible instead of hardware equipment because of the ready adaptability of the software. The result has been a significant increase in the overall flexibility of the system from the standpoint of available options as well as the operator's ability to define his requirements.

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Appendix

DATA CARD FORMATS

ALL OF THE FIELD COLUMNS AND THE CHECK SUM COLUMN ARE REQUIRED. THE
DIGIT CHECK SUM IS THE RESULT OF ADDING MODULO 10 ALL NUMBERS INCLUDING
PLUS AND MINUS SIGNS, WHERE + = 2 AND - = 1. OTHER CHARACTERS ARE
IGNORED, BUT ALL COLUMNS PRIOR TO THE SUM CHECK COLUMN MUST BE INCLUDED.

A. SITE CARDS

THE CARDS CONTAINING DATA FOR THE ROUTINE SITE ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD 1 CONTAINS COLUMNS 06-08
FIELD 2 CONTAINS COLUMNS 42-46
FIELD 3 CONTAINS COLUMNS 48-56
FIELD 4 CONTAINS COLUMNS 58-67
COLUMN 69 CONTAINS THE DIGIT CHECK SUM

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01-04	S I T E	MESSAGE PRINTOUT FOR THE HEADING THESE CHARACTERS ARE REQUIRED SINCE A CHARACTER SEARCH IS PERFORMED ON THEM.
05	BLANK	
06-08	XXX	SITE NUMBER, 001 THROUGH 999
09	BLANK	
10-39	ALPHABETIC	SITE LOCATION; E. G., WALDORF, MARYLAND AND OTHER INFORMATION (CLASSIFICATION, ETC.) IF DESIRED.
40	BLANK	
41-46	SXXXXX	HEIGHT ABOVE MEAN SEA LEVEL IN FEET THE SIGN IS EITHER + OR - OR BLANK
47	BLANK	
48	SIGN	LATITUDE, DEGREES-MINUTES-SECONDS N OR + OR BLANK FOR LATITUDE NORTH S OR - FOR LATITUDE SOUTH
49-50	XX	INTEGER DEGREES
51-52	XX	INTEGER MINUTES OF ARC
53-54	XX	INTEGER SECONDS OF ARC
55-56	XX	FRACTIONAL SECONDS OF ARC

51

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
57	BLANK	
58	SIGN	LONGITUDE, DEGREES-MINUTES-SECONDS W OR + OR BLANK FOR LONGITUDE WEST E OR - FOR LONGITUDE EAST
59-61	XXX	INTEGER DEGREES
62-63	XX	INTEGER MINUTES OF ARC
64-65	XX	INTEGER SECONDS OF ARC
66-67	XX	FRACTIONAL SECONDS OF ARC
68	BLANK	
69	CHECK SUM	
70-80	SPACES	UNUSED SPACES

B-I. SATELLITE CARD I

THE CARDS CONTAINING DATA FOR THE ORBIT ROUTINE ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

COLUMN 69 CONTAINS THE MODULO 10 CHECK SUM
NO OTHER FIELDS ARE CHECKED FOR INPUT ERRORS ON THE FIRST CARD.

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01	X	LINE NUMBER (I)
02	BLANK	
03-07	XXXXX	SATELLITE CATALOG NUMBER
08	BLANK	
09	X	CLASSIFICATION
10	BLANK	
11	X	SOURCE OF ELEMENTS (BLANK IF SPACETRACK OR 9 IF SPASUR
12-15	XXX	ELEMENT SET NUMBER
16	BLANK	
17-18	XX	INTERNATIONAL NAME, LAST TWO DIGITS OF THE YEAR
19-20	SPACE	BLANK SPACES
21-23	XXX	IDENTIFYING NUMBER OR GREEK LETTER NAME
24	SPACE	BLANK SPACE
25-27	XXX	PIECE NUMBER OR ALPHABETIC PIECE DESCRIPTION

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
28	BLANK	
29-30	XX	EPHEMERIS TYPE (NUMERIC CODE)
31	X	DIFFERENTIAL CORRECTION (NUMERIC CODE)
32	X	ATMOSPHERE (NUMERIC CODE)
33	BLANK	
34	X	ACCURACY (NUMERIC CODE)
35	BLANK	
36-39	XX.X	ESTIMATED ELEMENT LIFE FROM EPOCH (UP TO 99.9 DAYS) WITHIN SPECIFIED ACCURACY
40	BLANK	
41-46	XXXXXX	INTEGRAL REVOLUTIONS FROM LAUNCH AT EPOCH, N(O) FIRST REVOLUTION COMMENCES AT FIRST ASCENDING NODE
47	BLANK	
48	X	DATE OF EPOCH, LAST DIGIT OF CALENDAR YEAR
49-51	XXX	DAY OF THE YEAR
52	BLANK	
53-57	XXXXX	BALLISTIC COEFFICIENT, METERS SQUARED PER KILOGRAM DECIMAL FRACTION COEFFICIENT
58	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
59	X	EXPONENT OF TEN
60	BLANK	
61-65	XXXXX	REFLECTIVITY FACTOR, METERS SQUARED PER KILOGRAM DECIMAL FRACTION COEFFICIENT
66	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
67	X	EXPONENT OF TEN
68	BLANK	
69	CHECK SUM	
70-80	SPACES	UNUSED SPACES

B-2. SATELLITE CARD 2

THE CARDS CONTAINING DATA FOR THE ORBIT ROUTINE ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD 1 CONTAINS COLUMNS 09-22
FIELD 2 CONTAINS COLUMNS 24-31
FIELD 3 CONTAINS COLUMNS 33-40
FIELD 4 CONTAINS COLUMNS 42-49
FIELD 5 CONTAINS COLUMNS 51-58
FIELD 6 CONTAINS COLUMNS 60-67
COLUMN 69 CONTAINS THE MODULO 10 CHECK SUM

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01	X	LINE NUMBER (2)
02	BLANK	
03-07	XXXXX	SATELLITE CATALOG NUMBER
08	BLANK	
09-22	XXXXX.XXXXXX	EPOCH, T, MODIFIED JULIAN DAYS (JULIAN DAY MINUS 2,400,000.5)
23	BLANK	
24-31	XXX.XXXX	MEAN ANOMALY, M, DEGREES
32	BLANK	
33-40	XXX.XXXX	RIGHT ASCENSION OF THE ASCENDING NODE, DEGREES
41	BLANK	
42-49	XXX.XXXX	ARGUMENT OF PERIGEE, DEGREES
50	BLANK	
51-58	.XXXXXXX	ECCENTRICITY, E, (DIMENSIONLESS)
59	BLANK	
60-67	XXX.XXXX	INCLINATION, I, DEGREES
68	BLANK	
69	CHECK SUM	
70-80	SPACES	UNUSED SPACES

B-3. SATELLITE CARD 3

THE CARDS CONTAINING DATA FOR THE ORBIT ROUTINE ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD 1 CONTAINS COLUMNS 09-19
FIELD 2 CONTAINS COLUMNS 21-31
FIELD 3 CONTAINS COLUMNS 33-40
FIELD 4 CONTAINS COLUMNS 42-49
FIELD 5 CONTAINS COLUMNS 51-58
FIELD 6 CONTAINS COLUMNS 60-67
COLUMN 69 CONTAINS THE MODULO 10 CHECK SUM

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01	X	LINE NUMBER (3)
02	BLANK	
03-07	XXXXX	SATELLITE CATALOG NUMBER
08	BLANK	
09-19	XX.XXXXXXXX	MEAN MOTION, N, REVOLUTIONS/DAY
20	BLANK	
21-31	S.XXXXXXXXX	(1/2)*FIRST TIME DERIVATIVE OF MEAN MOTION, REVOLUTIONS/DAY**2 THE SIGN IS EITHER + OR - OR BLANK
32	BLANK	
33-40	SX.XXXXX	FIRST TIME DERIVATIVE OF RIGHT ASCENSION ASCENDING NODE, DEGREES/DAY THE SIGN IS EITHER + OR - OR BLANK
41	BLANK	
42-49	SX.XXXXX	FIRST TIME DERIVATIVE OF ARGUMENT OF PERIGEE, DEGREES/DAY THE SIGN IS EITHER + OR - OR BLANK
50	BLANK	
51	SIGN	FIRST TIME DERIVATIVE OF ECCENTRICITY, 1/DAY SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
52-56	XXXXX	DECIMAL FRACTION COEFFICIENT
57	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
58	X	EXPONENT OF TEN
59	BLANK	

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
60	SIGN	FIRST TIME DERIVATIVE OF INCLINATION, DEGREES/DAY SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
61-65	XXXXX	DECIMAL FRACTION COEFFICIENT
66	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
67	X	EXPONENT OF TEN
68	BLANK	
69	CHECK SUM	
70-80	SPACES	UNUSED SPACES

B-4. SATELLITE CARD 4

THE CARDS CONTAINING DATA FOR THE ORBIT ROUTINE ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD 1 CONTAINS COLUMNS 09-19
FIELD 2 CONTAINS COLUMNS 20-32
FIELD 3 CONTAINS COLUMNS 33-40
FIELD 4 CONTAINS COLUMNS 42-49
FIELD 5 CONTAINS COLUMNS 51-58
COLUMN 69 CONTAINS THE MODULO 10 CHECK SUM

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01	X	LINE NUMBER (4)
02	BLANK	
03-07	XXXXX	SATELLITE CATALOG NUMBER
08	BLANK	
09	SIGN	(1/6)*SECOND TIME DERIVATIVE OF MEAN MOTION, REVOLUTIONS PER DAY CUBED SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
10-17	XXXXXXXX	DECIMAL FRACTION COEFFICIENT
18	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
19	X	EXPONENT OF TEN
20	BLANK	
21	SIGN	(1/24)*THIRD TIME DERIVATIVE OF MEAN MOTION, REVOLUTIONS/DAY**4 SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
22-29	XXXXXXXX	DECIMAL FRACTION COEFFICIENT
30	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
31	X	EXPONENT OF TEN

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
32	BLANK	
33	SIGN	(1/2)*SECOND TIME DERIVATIVE OF RIGHT ASCENSION ASCENDING NODE, DEGREES/DAY**2 SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
34-38	XXXX	DECIMAL FRACTION COEFFICIENT
39	SIGN	SIGN OF THE EXPONENT, EITHER P OR - OR BLANK
40	X	EXPONENT OF TEN
41	BLANK	
42	SIGN	(1/2)*SECOND TIME DERIVATIVE OF ARGUMENT OF PERIGEE, DEGREES/DAY**2 SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
43-47	XXXX	DECIMAL FRACTION COEFFICIENT
48	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
49	X	EXPONENT OF TEN
50-59	BLANK	
60-67	SPACES	UNUSED SPACES
68	BLANK	
69	CHECK SUM	
70-80	SPACES	UNUSED SPACES

B-5. SATELLITE CARD 5

THE CARDS CONTAINING DATA FOR THE ORBIT ROUTINE ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD 1 CONTAINS COLUMNS 09-19
FIELD 2 CONTAINS COLUMNS 21-30
FIELD 3 CONTAINS COLUMNS 32-40
COLUMN 69 CONTAINS THE MODULO 10 CHECK SUM

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01	X	LINE NUMBER (5)
02	BLANK	
03-07	XXXXX	SATELLITE CATALOG NUMBER
08	BLANK	
09-19	XX.XXXXXXXX	SEMI-MAJOR AXIS, A, MEAN EQUATORIAL EARTH RADII

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
20	BLANK	
21	SIGN	FIRST TIME DERIVATIVE OF SEMI-MAJOR AXIS, EARTH RADII/DAY SIGN OF THE COEFFICIENT, EITHER + OR - OR BLANK
22-28	XXXXXXX	DECIMAL FRACTION COEFFICIENT
29	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BLANK
30	X	EXPONENT OF TEN
31	BLANK	
32	SIGN	(1/2)*SECOND TIME DERIVATIVE OF SEMI-MAJOR AXIS, EARTH RADII/DAY**2 SIGN OF THE COEFFICIENT, EITHER + OR - OR BOTH
33-39	XXXXX	DECIMAL FRACTION COEFFICIENT
40	SIGN	SIGN OF THE EXPONENT, EITHER + OR - OR BOTH
41	X	EXPONENT OF TEN
42	BLANK	
43	CHECK SUM	
44-80	SPACES	UNUSED SPACES

C. MOON CARDS

THE CARDS CONTAINING DATA FOR THE ROUTINE MOON ARE FORMATED AS SHOWN BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS FOLLOWS:

FIELD 1 CONTAINS COLUMNS 13-22
FIELD 2 CONTAINS COLUMNS 28-36
FIELD 3 CONTAINS COLUMNS 44-50
THERE IS NO CHECK SUM FOR THIS CARD.

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01-04	BLANK	
05-06	XX	DATE, YEAR-MONTH-DAY-HOUR YEAR
07-08	XX	MONTH
09-10	XX	DAY
11-12	XX	HOUR

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
13-14	XX	RIGHT ASCENSION, HOURS-MINUTES-SECONDS HOURS
15-16	XX	MINUTES
17-18	XX	INTEGER SECONDS
19-21	XXX	FRACTIONAL SECONDS
22-24	XXX	FIRST DIFFERENCE OF RIGHT ASCENSION, SECONDS/HOUR INTEGER SECONDS/HOUR
25-27	XXX	FRACTIONAL SECONDS/HOUR
28	SIGN	DECLINATION, DEGREES-MINUTES-SECONDS THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
29-30	XX	INTEGER DEGREES
31-32	XX	INTEGER MINUTES OF ARC
33-34	XX	INTEGER SECONDS OF ARC
35-36	XX	FRACTIONAL SECONDS OF ARC
37	SIGN	FIRST DIFFERENCE OF DECLINATION, SECONDS/HOUR THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
38-41	XXXX	INTEGER SECONDS/HOUR
42-43	XX	FRACTIONAL SECONDS/HOUR
44-45	XX	HORIZONTAL PARALLAX, MINUTES-SECONDS INTEGER MINUTES OF ARC
46-47	XX	INTEGER SECONDS OF ARC
48-50	XXX	FRACTIONAL SECONDS OF ARC
51	SIGN	FIRST DIFF. OF HORIZONTAL PARALLAX, SECONDS/HOUR THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
52	X	INTEGER SECONDS/HOUR
53-55	XXX	FRACTIONAL SECONDS/HOUR
56-64	1960 ONLY	DECLINATION FOR 1960 ONLY
65-80	BLANK	UNUSED SPACES

D. PLANET CARDS

THE CARDS CONTAINING DATA FOR THE ROUTINE PLANET ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD I CONTAINS COLUMNS 11-19
FIELD 2 CONTAINS COLUMNS 27-35
FIELD 3 CONTAINS COLUMNS 51-58

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01-02	XX	MONTH JAN.-DEC., 01-12
03-04	BLANK	
05	X	PLANET NUMBER 1 THROUGH 9
06-07	XX	DATE, YEAR-MONTH-DAY YEAR
08	X	MONTH JAN.-SEPT., 1-9; OCT., 0; NOV., X; DEC., Y
09-10	XX	DAY
11-12	XX	RIGHT ASCENSION, HOURS-MINUTES-SECONDS HOURS
13-14	XX	MINUTES
15-16	XX	INTEGER SECONDS
17-19	XXX	FRACTIONAL SECONDS COLUMN 19 IS BLANK FOR MERCURY, VENUS, AND MARS.
20	SIGN	FIRST DIFFERENCE RIGHT ASCENSION, SECONDS/DAY THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
21-23	XXX	INTEGER SECONDS/DAY
24-26	XXX	FRACTIONAL SECONDS/DAY COLUMN 26 IS ZERO FOR MERCURY, VENUS, AND MARS.
27	SIGN	DECLINATION, DEGREES-MINUTES-SECONDS THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
28-29	XX	INTEGER DEGREES
30-31	XX	INTEGER MINUTES OF ARC
32-33	XX	INTEGER SECONDS OF ARC
34-35	XX	FRACTIONAL SECONDS OF ARC COLUMN 35 IS BLANK FOR MERCURY, VENUS, AND MARS.

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
36	SIGN	FIRST DIFFERENCE OF DECLINATION, SECONDS/DAY THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
37-40	XXXX	INTEGER SECONDS/DAY
41-42	XX	FRACTIONAL SECONDS/DAY COLUMN 42 IS ZERO FOR MERCURY, VENUS, AND MARS.
43-44	XX	SEMI-DIAMETER INTEGER SECONDS OF ARC
45-46	XX	FRACTIONAL SECONDS OF ARC
47-48	XX	HORIZONTAL PARALLAX, SECONDS OF ARC INTEGER SECONDS OF ARC
49-50	XX	FRACTIONAL SECONDS OF ARC
51-52	XX	TRUE DISTANCE FROM EARTH, ASTRONOMICAL UNITS
53-58	XXXXXX	FRACTION OF AN ASTRONOMICAL UNIT COLUMN 58 IS BLANK FOR URANUS AND NEPTUNE.
59	SIGN	FIRST DIFFERENCE OF TRUE DISTANCE, ASTRONOMICAL UNITS/DAY THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
60-64	XXXXX	FRACTION OF AN ASTRONOMICAL UNIT/DAY COLUMN 64 IS ZERO FOR URANUS AND NEPTUNE.
65-66	XX	EPHEMERIS TRANSIT, HOURS-MINUTES-SECONDS HOURS
67-68	XX	MINUTES
69-70	XX	SECONDS
71-80	USED	THESE COLUMNS ARE USED FOR OBSERVATORY PURPOSES.

E. STAR CARDS

THERE IS NO CHECK SUM FOR THIS CARD.

THE CARDS CONTAINING DATA FOR THE ROUTINE STAR ARE FORMATED AS SHOWN BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS FOLLOWS:

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01-07	ALPHABETIC	GREEK LETTER NAME
08	X	SUBSCRIPT
09-11	SXX	NUMBER BLANK, NUMERIC, OR ALPHABETIC CHARACTERS THE SIGN IS A Y FOR A PLUS OR AN X FOR A MINUS.

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
12-17	XXXXXX	NAME NUMERIC OR ALPHABETIC CHARACTERS
18-19	X	MAGNITUDE BLANK, NUMERIC, OR ALPHABETIC CHARACTERS ONLY
20	X	NUMERIC OR ALPHABETIC ONLY
21	X	BLANK OR NUMERIC ONLY
22	X	SPECTRAL TYPE ALPHABETIC CHARACTERS ONLY
23	X	BLANK OR NUMERIC ONLY
24	X	BLANK OR ALPHABETIC ONLY
25	X	BLANK OR NUMERIC ONLY
26-30	XXXXX	G. C. NUMBER
31-32	BLANK	
33-34	XX	RIGHT ASCENSION HOURS
35-36	XX	MINUTES
37-38	XX	INTEGER SECONDS
39	X	FRACTIONAL SECONDS
40	SIGN	DECLINATION THE SIGN IS A 0 (ZERO) FOR A PLUS AND AN X FOR A MINUS.
41-42	XX	INTEGER DEGREES
43-44	XX	INTEGER MINUTES OF ARC
45-46	XX	INTEGER SECONDS OF ARC
47-75	USED	THESE COLUMNS ARE USED FOR OBSERVATORY PURPOSES.
76	X	YEAR
77-80	BLANK	UNUSED SPACES

F. SUN CARDS

THE CARDS CONTAINING DATA FOR THE ROUTINE SUN ARE FORMATED AS SHOWN
BELOW. THE FIELDS WHICH ARE CHECKED FOR INPUT ERRORS ARE DEFINED AS
FOLLOWS:

FIELD 1 CONTAINS COLUMNS 11-19
FIELD 2 CONTAINS COLUMNS 25-33
FIELD 3 CONTAINS COLUMNS 40-48
THERE IS NO CHECK SUM FOR THIS CARD.

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
01-02	XX	MONTH JAN.-DEC., 01-12
03-04	BLANK	
05	X	SUN CODE, 0 (ZERO)
06-07	XX	DATE, YEAR-MONTH-DAY YEAR
08	X	MONTH JAN.-SEPT., 1-9; OCT., 0; NOV., X; DEC., Y
09-10	XX	DAY
11-12	XX	RIGHT ASCENSION, HOURS-MINUTES-SECONDS HOURS
13-14	XX	MINUTES
15-16	XX	INTEGER SECONDS
17-19	XXX	FRACTIONAL SECONDS COLUMN 19 INCLUDES A ROUNDING 5.
20-22	XXX	FIRST DIFFERENCE OF RIGHT ASCENSION, SECONDS/DAY INTEGER SECONDS/DAY
23-24	XX	FRACTIONAL SECONDS/DAY
25	SIGN	DECLINATION, DEGREES-MINUTES-SECONDS THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
26-27	XX	INTEGER DEGREES
28-29	XX	INTEGER MINUTES OF ARC
30-31	XX	INTEGER SECONDS OF ARC
32-33	XX	FRACTIONAL SECONDS OF ARC COLUMN 33 INCLUDES A ROUNDING 5.
34	SIGN	FIRST DIFFERENCE OF DECLINATION, SECONDS/DAY THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
35-38	XXXX	INTEGER SECONDS/DAY
39	X	FRACTIONAL SECONDS/DAY

CARD COLUMN NUMBER	COLUMN CHARACTERS (X=DIGIT)	TYPE OF DATA CONTAINED IN THE COLUMN
40	X	RADIUS VECTOR, ASTRONOMICAL UNITS INTEGER ASTRONOMICAL UNITS
41-48	XXXXXXX	FRACTION OF AN ASTRONOMICAL UNIT COLUMN 48 INCLUDES A ROUNDING 5.
49	SIGN	FIRST DIFFERENCE OF RADIUS VECTOR, ASTR. UNITS/DAY THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
50-53	XXXX	INTEGER ASTRONOMICAL UNITS/DAY * (10**-7)
54-55	XX	SEMI-DIAMETER, MINUTES-SECONDS INTEGER MINUTES OF ARC
56-57	XX	INTEGER SECONDS OF ARC
58-59	XX	FRACTIONAL SECONDS OF ARC
60	SIGN	EQUATION OF TIME, MINUTES-SECONDS THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
61-62	XX	INTEGER MINUTES
63-64	XX	INTEGER SECONDS
65-67	XXX	FRACTIONAL SECONDS COLUMN 67 INCLUDES A ROUNDING 5.
68	SIGN	FIRST DIFFERENCE OF EQUATION OF TIME, SECONDS/DAY THE SIGN IS AN 8 FOR A PLUS AND AN X FOR A MINUS.
69-70	XX	INTEGER SECONDS/DAY
71-72	XX	FRACTIONAL SECONDS/DAY
73-79	XXXXXXX	JULIAN DATE, DAYS INTEGRAL DAYS COLUMN 79 HAS AN OCCASIONAL X OR Y PUNCH.
80	X	FRACTIONAL DAYS COLUMN 80 HAS AN OCCASIONAL X OR Y PUNCH.